Isolating angle in infants' detection of shape

Moira R. Dillon[1], **Véronique Izard**[2,3], **& Elizabeth Spelke**[1]

[1]Harvard University, [2]Centre National de la Recherche Scientifique, [3]Université Paris Descartes

Introduction

• Sensitivity to shape information arises early in human development and is critical to recognizing and naming objects (Smith, 2009).

• Research with young children has linked the geometry used during object recognition to more complex geometric skills, like reading maps (Dillon et al., 2013).

• Schwartz & Day (1979) revealed that young infants are sensitive to the lengths and angles of contours in both closed and open figures under some circumstances.

• Subsequent studies refining these results (Cohen & Younger, 1984; Slater et al., 1991) nevertheless do not specify the shape information effecting shape detection in infants.

• Do young infants detect shape changes when size, orientation, and direction are controlled for (Exps. 1-2) and when relative length and angle are deconfounded (Exps. 3-4)?

Methods

In four experiments, we used the change-detection paradigm of Libertus & Brannon (2010) to evaluate infants' sensitivity to shape. We measured infants' tendency to look longer at displays in which a triangle or "L" changed in shape and size, versus one in which the triangle or "L" changed in size only (see left middle panel).

Participants

The sample included 62 infants aged 6mo15d - 7mo15d (Mage 6mo30d). An additional 6 infants participated in the study, but were excluded because of excessive fussiness (2), parental interference (2), or total looking more than two standard deviations below the mean (2).

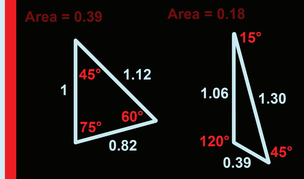
Displays and Procedure

Images were presented on either side of a large screen within two rectangular boxes. In all experiments, image size (+/- 5%) and position (+/- 10px in the horizontal and vertical directions) varied randomly. In Exp. 1, image orientation varied by +/- 30°, and in Exps. 2-4, image orientation varied from 0°-360°, as did left/right direction. Each image was presented for 500ms with a 300ms blank screen between presentations. Four 60s blocks were shown to each infant, with the location of each type of change alternating between blocks. The location of the shape change during the first block was counterbalanced across infants.

Dependent Measure

Preference scores were calculated as the proportion of looking to the shape and size change displays versus the size change displays only across all four blocks.

Exps. 1 & 2



Dimensions and measurements for the triangles used in Exps. 1 & 2.

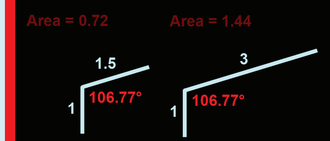
On one side of the screen infants saw these two triangles flipping back and forth. On the other side, infants saw one of these triangles flipping back and forth with another of the same shape, but of a different size. This "size deviant" had the same area as the shape deviant.

Example displays from Exp. 2.

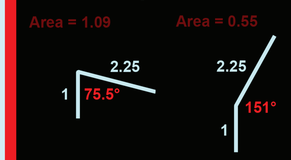
• One triangle was presented changing in shape and size on one side (here, left) and another in size only on the other side (here, right). The relevant change is indicated across the diagonal in this image.

• At each presentation, these triangles changed randomly in size, position, orientation (0°-360°) and left/right direction.

Exp. 3



Exp. 4

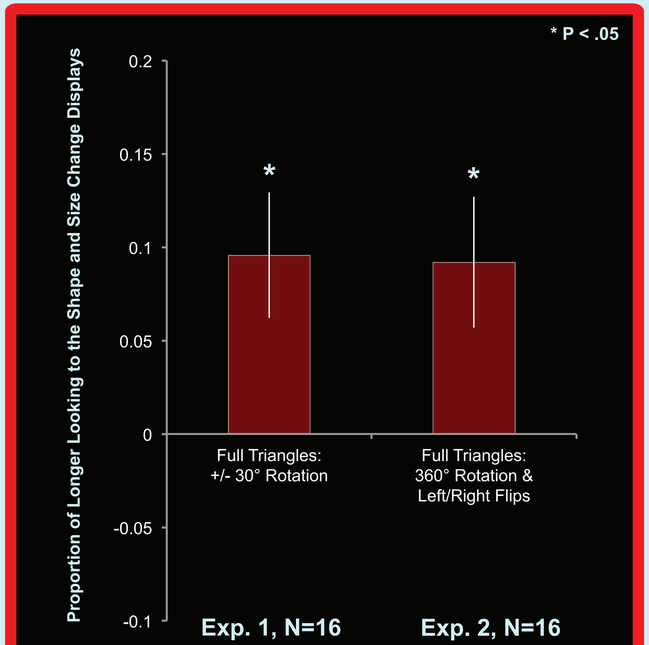


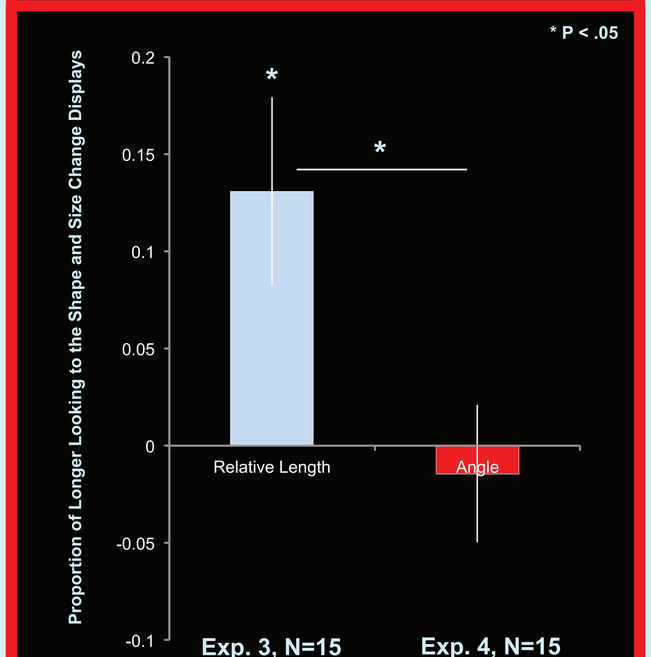
Dimensions and measurements of the "L" shapes used in Exps. 3 & 4.

In the relative length condition (Exp. 3), infants viewed "L" shapes changing in relative length by a factor of two.

In the angle conditon (Exp. 4), infants viewed "L" shapes changing in angle by a factor of two.

Across conditions, the size deviants (measured by the area of the implied triangle) also varied by a factor of two.





Results

Across experiments, infants looked on average 88.89s across four blocks (min: 39.69s, max: 152.15s).

In Exps. 1 & 2, infants looked longer at displays in which triangles changed in shape and size versus those in which triangles changed in size only (top right middle panel).

In Exps. 3 & 4, which deconfounded relative length and angle, infants looked longer at "L" shapes changing in relative length and size versus those changing in size only, but infants did not look longer at "L" shapes changing in angle and size versus those changing in size only (bottom right middle panel).

Conclusion

• Previously observed sensitivities to "shape" may be explained by a single sensitivity to relative length.

• Alternatively, if infants compute angles by first detecting individual orientations and then comparing across these orientations, they may fail to detect angle in the present study because line orientations are changing from image to image and exposures are brief.

• A research program investigating the ages and conditions under which different geometric properties are detectable may inform our understanding of early object recognition and may aid a pedagogy of geometry aimed at young children.

References

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