Hole-d Everything: How Preschoolers Label and Reason about Holes

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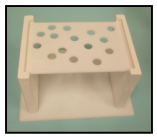
Preschoolers identify, track, and count large circular (prototypical) holes much as they do objects,[1] but our own informal observations suggested that some children extend the term "hole" differently than adults would. While research shows that infants attend to gaps and apertures in support and containment events, less is known about preschoolers' reasoning about the functional implications of holes. Here we explore young children's judgments about what qualifies as a "hole" when categorizing and when predicting causal outcomes.

Study 1

Method

Participants: 58 preschoolers (mean= 4;6, range= 3;5-5;5, 35 girls) from diverse SES and ethnic backgrounds, about 35% of whom spoke Spanish as a home language.

Materials: 17 4.5"X7" white Plexiglas plates. One had no holes. Eight had real holes, and 8 had painted "holes." Holes/"holes" were large or small, circular or square, and randomly or regularly patterned.



Procedure: Children were encouraged to interact with the plates before answering questions. Task order was counterbalanced.

Sand Task

Children predicted the outcome of pouring sand over plates with and without real holes.

Sort Task

Subjects sorted plates "with holes" and "with no holes" into two groups.

Questions & Findings

1.Do children accurately predict outcomes when sand is poured over holes and "holes?"
Yes. Group means for the sand task exceeded chance, (15.55 of 17, *s.e.* = .28, t(*57*) = 22.24, $p < .001$).

52 of 58 Ss passed by the binomial criterion.

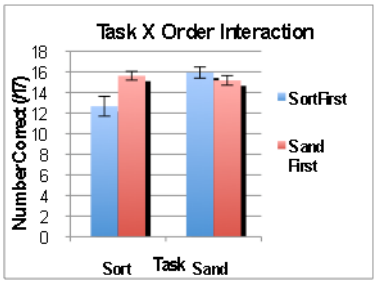
2.Do children sort accurately?
Yes. Group means for the sort task exceeded chance, (14.14, *s.e.* = .58, $t(57) = 9.71$, $p < .001$).

43 Ss passed by the binomial criterion.

3. Do children perform more accurately when making functional predictions (sand task) than when sorting by label?
Yes. A main effect for task was found, $F(1, 56) = 7.629$, $p < .01$.

Of the 14 individuals who passed only one task, 12 passed the sand task and 2 passed the sort task ($p < .01$, binomial).

4. Does consideration of function facilitate sorting?
Yes. While there was no main effect of task order, an interaction of order and task was found. Children who completed the sand task first had reliably higher sorting scores than did those who sorted before they considered the functional properties of holes, $F(1, 56) = 13.234$, $p < .001$.



5. Which characteristics of holes impacted performance?
Sand and sort mean scores were above chance for each of the 17 plates.

Children **judged large holes/"holes" more accurately** than small ones, $t(57) = 3.025$, $p < .01$.

Still, children judged square holes or "holes" more accurately than round ones, $t(57) = 2.299$, $p < .03$. While children accurately sorted real circular holes, real square holes, and fake square holes, they made more mistakes on fake circular holes, treating them as real (post hoc analysis).

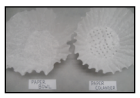
Neither reality status nor patterning influenced children's judgments.

Study 2

Method

Participants: 72 preschoolers (mean=4;6, range=4;0-5;3, 37 girls) from similar backgrounds as those in Study 1.

Materials:



Procedure: Children judged whether pouring each substance into each bowl would "be okay" or "make a mess." They were asked to justify their responses.

Questions & Findings

1. Do children accurately predict outcomes of a pouring event?
Yes. Group means exceeded chance (9.6 out of 12; *s.e.* = .27).

57 out of 72 Ss passed by the binomial criterion.

2. Did the presence of holes affect accuracy?
No. Means for trials with colanders were not significantly different than trials with bowls; $t(142) = .441$, $p = .66$.

Considering *metal* trials only (which provides a clearer test of the holes question), there was no difference for bowls vs. colanders, $t(142) = 1.494$, $p = .14$.

On one key trial children had to coordinate the size of the gravel and the size of the holes to judge that pouring gravel in the metal colander would be "ok." Of the 52 Ss who correctly predicted that water and sand would make a mess, 43 knew that the gravel would not do so.

3. Did children refer to holes and other relevant functional characteristics to justify their responses?
Children justified most correct responses (86%).

To justify their choices, children most often referred to relevant design features of the containers (e.g., holes) and consequences of the pouring action (e.g., "mess because it would go right through the tiny holes"). They paid attention to characteristics of both the containers and the substances (e.g., "OK 'cause the rocks are big and the holes are small" or "It will make a trickle because the water falls in the hole").

Holes (or a term that referred to holes) were the most often mentioned relevant design feature.

Conclusion

The present exploratory work examined children's conception of holes, focusing on (1) their ideas about the implications of holes under various functional circumstances and (2) the characteristics of entities to which they apply the term. Taken together, the results suggest appropriate attention to the functional implications of perforations, some lag in the ability to accurately sort items as having holes or not, and a tendency for size and shape of holes to influence these judgments.

Reference
[1] Giralt, N., & Bloom, P. (2000). How special are objects? Children's reasoning about objects, parts, and holes. *Psychological Science, 11*, 497-501.

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