



Forces are in Action: Causal Understanding of Preschoolers

Tilbe Göksun¹, Kathy Hirsh-Pasek¹, Kelly Fisher¹, Yannos Mitiszlis¹, Katrina Ferrara¹, & Roberta M. Golinkoff²

Temple University¹

University of Delaware²



BACKGROUND

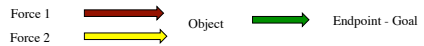
Major Question: How do preschoolers understand the causal events that take place in their world? Are they able to use multiple physical forces in tandem to evaluate the causal relationships they observe?

- Most studies of causal understanding focus on the relationship between two objects (Michotte, 1963; Scholl & Tremoulet, 2000).
- Wolff's Dynamic Model of Causation (adapted from Talmy, 1988) suggests multiple forces yield three subcategories of cause:

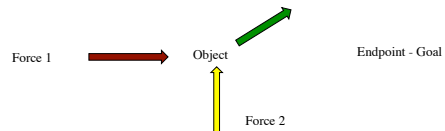
1. **CAUSE:** a force moves the object – **1 force, 1 vector** (e.g., I rolled the ball into the goal box)



2. **ENABLE:** a secondary force *promotes* movement – **2 forces, 1 vector** (e.g., the fan helped the ball roll into the goal box)



3. **PREVENT:** a secondary force *impedes* movement – **2 forces, 2 vectors** (e.g., the fan blew the ball away from the goal box)



- By age 4, children make proper causal inferences about physical relations (e.g., Bullock, Gelman, & Baillargeon, 1982; Spelke, Breilinger, Macomber, & Jacobson, 1992; Schulz & Gopnik, 2004).
- Yet, even elementary school children have difficulty in integrating multiple forces to predict the result of an event (Pauen, 1996).

Our Study: Originating from Wolff's *Dynamics Model*, we examine preschoolers' representation of causal events with respect to the forces described using Wolff's three types of causal relations (Cause, Enable, and Prevent).

RESEARCH QUESTIONS

- Do 4- and 5-year-olds predict the direction and endpoint of different causal events (Cause, Enable, and Prevent), representing single- and two-force relations?

Hypotheses:

- 1) Single-force > two-force
- 2) Cause > Enable > Prevent

- Does the direction of the causal event matter?

Hypothesis:

Horizontal > Diagonal

METHOD

Participants

- 16 4-year-olds ($M=53.97$ mo., $SD=3.51$ mo.)
- 14 5-year-olds ($M=64.86$ mo., $SD=2.06$ mo.)
- Balanced for gender

Apparatus and Procedure

- The task was adapted from Wolff's stimuli.
- A ball dropped through the fort and rolled across a 180X180 cm grid
- 2 forces acted on the ball: person and hairdryer (see below)
- Children predicted where the ball would stop in single-force (Phase 1) and two-force trials (Phase 2) by placing a colored square on the grid prior to each trial.

Phase 1: CAUSE (3 Single-force Trials)

- The ball dropped through the fort or the hairdryer pushed the ball to the fort (trials = horizontal and diagonal directions to the child)

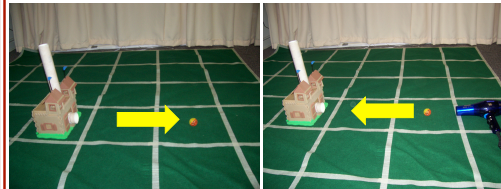


Figure 1. Examples of single-force test trials. The yellow arrow represents the direction of the force either dropped by a person (left) or blown by the hairdryer (right).

Phase 2: ENABLE and PREVENT (4 Two-force Trials)

- Enable: The movement was propelled by the hairdryer (Fig 2, left)
- Prevent: Hairdryer added force in opposite direction (Fig 2, right) (Trials = horizontal and diagonal directions to the child)

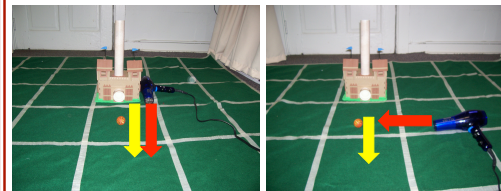


Figure 2. Two-force test trials. The yellow arrow represents the direction of the ball when dropped by a person and the red arrow represents the direction of the hairdryer.

Coding: the direction and the endpoint of children's responses were coded. 95% agreement between two coders.

- IVs: Single and two-force trials, direction (horizontal and diagonal), age

- DV: % of correct predictions of the endpoint (the square) and the direction of the movement.

RESULTS

Do 4- and 5-year-olds predict the direction and endpoint of different causal events (Cause, Enable, and Prevent), representing single- and two-force relations? YES!

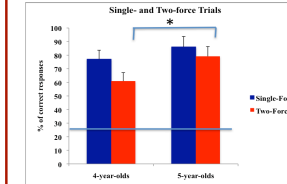


Figure 3. Percentage of correct responses in single- and two-force trials at both age groups

Children predicted the direction of the single and two-force causal events above chance level ($p < .01$).

For only 4-year-olds: Single-force > Two-force ($p < .05$)

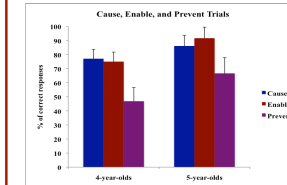


Figure 4. Percentage of correct responses in Cause, Enable, and Prevent trials at both age groups

For both age groups: Cause = Enable > Prevent ($p < .05$)

Does the direction of the causal event matter? YES!

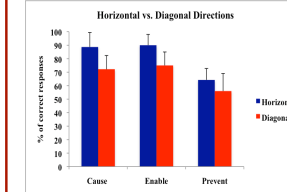


Figure 5. Percentage of correct responses for horizontal and diagonal directions in Cause, Enable, and Prevent trials

For all causal relations: Horizontal > Diagonal

DISCUSSION

- This study is among the first to developmentally test Dynamics Model of Causation in terms of directions and forces. We asked children to predict the direction and endpoint of an object (the ball) in 3 types of causal relations (Cause, Enable, and Prevent). Results suggested that similar to adults, children represent cause and respond to different categories of cause.

- Children are sensitive to number and direction of forces in causal relationships: They are better at reasoning about single force causal events and horizontal directions.

- Children are worse in Prevent relations: One reason might be that children are unable to integrate two vectors of forces to predict the goal of action.

Address correspondence to: Tilbe Göksun, Temple University, Temple Infant Lab, 580 Meetinghouse Rd, Ambler, PA 19002 Email: tgöksun@temple.edu