JoVE: Science Education

How Children Solve Problems Using Causal Reasoning

--Manuscript Draft--

Manuscript Number:	10110
Full Title:	How Children Solve Problems Using Causal Reasoning
Article Type:	Manuscript
Section/Category:	Manuscript Submission
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PIs: Judith Danovitch and Nicholaus Noles

Psychology Education Title: How Children Solve Problems Using Causal Reasoning

Overview:

Imagine a young child hears an adult say, "I want to watch the news," then watches the adult press a button on the remote control. A moment later, the television screen turns on. The next day, the child wants to turn on the television screen to watch cartoons. How does the child know what to do? Is it enough to say, "I want to watch cartoons," or is pushing the button on the remote control necessary, too? Solving this problem requires children to use the information they observed (i.e. the adult's behaviors) to come up with a solution. In their daily lives, children encounter many situations where they need to decode cause-and-effect from complex or ambiguous observations in order to accomplish a goal.

In order to examine children's capacity for causal reasoning, psychologists set up tasks using causal scenarios to observe how children draw conclusions and test new hypotheses about the relationships between different types of objects. In these tasks, children are shown interactions involving individual objects or sets of objects. Then, they are asked to identify and use the links between the causes and the effects to solve a problem.

This video demonstrates how to measure children's causal reasoning about novel objects based on the methods developed by Gopnik and Sobel (2000) and Gopnik, Sobel, Shulz, and Glymour (2001).

Procedure:

1. Recruit children ages 3 and 4. For the purposes of this demonstration, only one child is tested. Larger sample sizes (as in the Gopnik and Sobel (2000) and Gopnik, Sobel, Schulz, and Glymour (2001) studies) are recommended when conducting any experiments.

    1.1. Make sure the participants have no history of developmental disorders and have normal hearing and vision.

2. Obtain the necessary materials.

    2.1. Gather a set of 4 wooden blocks of different colors and shapes.

    2.2. Prepare a special device that plays music when triggered.

        2.2.1. To build this device, get a box approximately 5″ x 7″ x 3″ with a sturdy top.

        2.2.2. Inside the box, place a sound-producing device that can be remotely activated (a wireless speaker or a doorbell may work well for this purpose).

2.2.3. Ensure that there is a way to turn the device on or off during the experiment without the child noticing.

3. Data collection.

3.1. Introduction.

3.1.1. Sit the child on the opposite side of the table from the experimenter with the device on the table between them.

3.1.2. Introduce the device as follows, “Some blocks make this machine go, and some blocks don't.”

3.1.3. Instruct the child to figure out which blocks make the machine work.

3.2. One-cause task.

3.2.1. In this task, only one block sets off the device.

3.2.2. Place one block (Block B) on the device and demonstrate that nothing happens.

3.2.3. Place a second block (Block A) on the device and activate it so the music plays.

3.2.4. With Block A still on the device, place Block B back on the device. Have the machine continue playing music.

3.2.4.1. Counterbalance the position (to the left or right of Block A) of Block B between subjects.

3.2.5. Ask the child, “Can you make it stop?” and note the child’s actions.

3.3. Two-cause task.

3.3.1. In this task, two blocks set off the device.

3.3.2. Use different blocks than those used in the one-cause task.

3.3.3. Place Block B on the device and activate it so the music plays.

3.3.4. Remove Block B, then place Block A on the device, and activate it so the music plays.

3.3.5. With Block A still on the device, place Block B back on the machine.

3.3.5.1. Counterbalance the position (to the left or right of Block A) of Block B between subjects.

3.3.6. Ask the child, "Can you make it stop?" and note the child's actions.

4. Analysis.

4.1. Categorize the children's responses for each task into four categories: removing block A only, removing Block B only, removing both blocks, or not removing any blocks.

4.2. Compare the number of children who removed Block A in the one-cause and two-cause tasks using chi-square tests.

4.3. Compare the number of children who removed both blocks in the one-cause and two-cause tasks using chi-square tests.

4.4. If children remove Block A more often in the one-cause task than in the two-cause task, and if children remove both blocks more often in the two-cause than in the one-cause task, then this suggests that they can use their observations to deduce which block caused the device to go off.

Representative Results:

Researchers tested 24 3- and 4-year-old children. They found the children's most frequent response in the one-cause task was to remove Block A from the device, and the children did so significantly more often than in the two-cause task. Likewise, children's most frequent response in the two-cause task was to remove both blocks, and they did so significantly more often than in the one-cause task. The researchers also noted that when children in the two-cause task only chose one block, they were equally likely to choose Block A or Block B (**Figure 1**). This suggests they did not believe either block had a stronger effect on the device. The researchers concluded that preschool children were able to use their previous observations and their causal reasoning skills to solve the problem of how to turn off the device.

Applications:

These findings show the power of children's causal reasoning abilities for solving problems. Children can learn about the world quickly, and they can use their knowledge to figure out the causal relationships between objects. This is true even if they have never seen the objects before (for example, the music-playing device) and no one has previously demonstrated how to solve the problem.

The ability to use observations to draw inferences about cause-and-effect and to apply those inferences to solving novel problems is one of the basic elements of scientific understanding. The scientific methods rely on the practice of systematically testing how manipulation of

different variables produces different effects on the world. These findings suggest that, even before they begin their formal science education, children already have the capacity to reason about the causal relationships between objects in the world. Moreover, they are able to creatively use their understanding to solve problems, even if they have never observed the objects or problems before (**Figure 2**).

Legend:

Figure 1: Percentage of children who showed each type of response pattern in the one-cause and two-cause tasks.

Figure 2: Children problem solving.

References:

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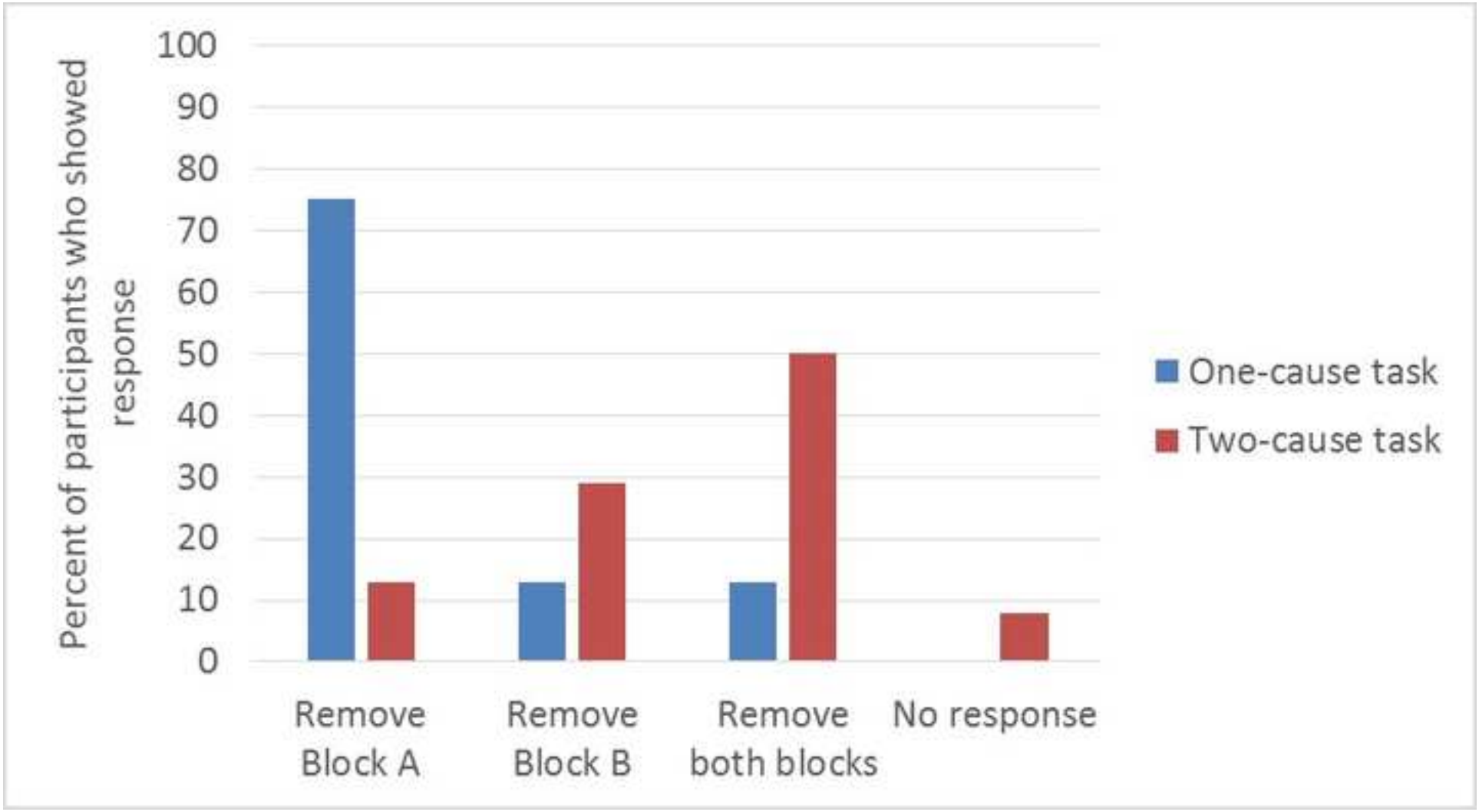

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Comment [JS1]: Will the same child be used to demonstrate the two tasks?

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