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Young children use physics, not previous rewards, to learn about tools

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Children as young as seven apply basic laws of physics to problem-solving, rather than learning from what has previously been rewarded, suggests new research from the University of Cambridge.

The findings of the study, based on the Aesop's fable The Crow and the Pitcher, help solve a debate about whether children learning to use tools are genuinely learning about physical causation or are just driven by what action previously led to a treat.

Learning about causality - about the physical rules that govern the world around us - is a crucial part of our cognitive development. From our observations and the outcome of our own actions, we build an idea - a model - of which tools are functional for particular jobs, and which are not.

However, the information we receive isn't always as straightforward as it should be. Sometimes outside influences mean that things that should work, don't. Similarly, sometimes things that shouldn't work, do.

Dr Lucy Cheke from the Department of Psychology at the University of Cambridge says: "Imagine a situation where someone is learning about hammers. There are two hammers that they are trying out - a metal one and an inflatable one. Normally, the metal hammer would successfully drive a nail into a plank of wood, while the inflatable hammer would bounce off harmlessly.

"But what if your only experience of these two hammers was trying to use the metal hammer and missing the nail, but using the inflatable hammer to successfully push the nail into a large pre-drilled hole? If you're then presented with another nail, which tool would you choose to use? The answer depends on what type of information you have taken from your learning experience."

In this situation, explains, Cheke, a learner concerned with the outcome (a 'reward' learner) would learn that the inflatable hammer was the successful tool and opt to use it for later hammering. However, a learner concerned with physical forces (a 'functionality' learner) would learn that

the metal hammer produced a percussive force, albeit in the wrong place, and that the inflatable hammer did not, and would therefore opt for the metal hammer.

Now, in a study published in the open access journal *PLOS ONE*, Dr Cheke and colleagues investigated what kind of information children extract from situations where the relevant physical characteristics of a potential tool are observable, but often at odds with whether the use of that tool in practice achieved the desired goal.

The researchers presented children aged 4-11 with a task through which they must retrieve a floating token to earn sticker rewards. Each time, the children were presented with a container of water and a set of tools to use to raise the level. This experiment is based on one of the most famous Aesop's fables, where a thirty crow drops stones into a pitcher to get to the water.

In this test, some of the tools were 'functional' and some 'non-functional'. Functional tools were those that, if dropped into a standard container, would sink, raising the water level and bringing the token within reach; non-functional tools were those that would not do so, for example because they floated.

However, sometimes the children used functional tools to attempt to raise the level in a leaking container - in this context, the water would never rise high enough to bring the token within reach, no matter how functional the tool used.

At other times, the children were successful in retrieving the reward despite using a non-functional tool; for example, when using a water container that self-fills through an inlet pipe, it doesn't matter whether the tool is functional as the water is rising anyway.

After these learning sessions, the researchers presented the children with a 'standard' water container and a series of choices between different tools. From the pattern of these choices the researchers could calculate what type of information was most influential on children's decision-making: reward or function.

"A child doesn't have to know the precise rules of physics that allow a tool to work to have a feeling of whether or not it should work," says Elsa Loissel, co-first author of the study. "So, we can look at whether a child's decision making is guided by principles of physics without requiring them to explicitly understand the physics itself.

"We expected older children, who might have a rudimentary understanding of physical forces, to choose according to function, while younger children would be expected to use the simpler learning approach and base their decisions on what had been previously rewarded," adds co-first author Dr Cheke. "But this wasn't what we found."

Instead, the researchers showed that information about reward was never a reliable predictor of children's choices. Instead, the influence of functionality information increased with age - by the age of seven, this was the dominant influence in their decision making.

"This suggests that, remarkably, children begin to emphasise information about physics over information about previous rewards from as young as seven years of age, even when these two types of information are in direct conflict."

More information: Elsa Loissel, Lucy Cheke & Nicola Clayton. Exploring the Relative Contributions of Reward-History and Functionality Information to Children's Acquisition of The Aesop's Fable Task. *PLOS ONE*; 23 Feb 2018; DOI: 10.1371/journal.pone.0193264

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