Corvids create novel causal interventions after all

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Using a novel paradigm, Taylor et al. [1] recently investigated whether New Caledonian crows make causal interventions in comparison to 24-month-old children. They view a causal intervention as the ability, after having only observed a correlation between cause and effect, to produce a novel behavioural pattern to recreate the same outcome. They conclude that New Caledonian crows cannot make causal interventions, whereas most children can. They also question whether any previous work has provided evidence for causal interventions in corvids. We argue that their conclusions are premature because of both methodological and theoretical limitations to their study, and because their analysis of previous work is ambiguous.

In their study, the crows faced a transparent apparatus with six holes, in which a particular object (‘block’ hereafter) could be inserted. A cylinder in the centre of the apparatus, containing a piece of food, could be triggered to rotate if the block was inserted into the correct hole. The block would then fall onto the cylinder, causing food to be dispensed.

In observation trials, a piece of food was attached to the block with wire, which was then placed on the ledge of the ‘rewarding’ hole. When the bird retrieved the food, this caused the block to fall and rotate the cylinder, thereby releasing the additional reward: a set-up intended to present an accidental causal effect. In the subsequent experimental trials, the hole contained no food, and the block without food and wire was placed on the ground next to the apparatus. To get the food, the crow had to pick up the block and push it into the correct hole.

The crows obtained both pieces of food in all 100 observation trials. They never obtained the food in any of the 100 experimental trials; moreover, they stopped approaching the apparatus. Crows in a control group could execute the key behaviour—only after their behaviour was shaped. The same apparatus was used on 2-year-old children, using marbles as rewards. Most children solved the experimental task after approximately three observation and three experimental trials.

The authors argue that previous corvid studies failed to show the ability to make causal interventions. In a comparable study by von Bayern et al. [2], New Caledonian crows were trained to collapse a platform by pressing it with their beak, causing food to be released from a transparent box. They then faced a situation with the platform out of reach, where they instead dropped stones onto the platform, causing it to collapse. Taylor et al. [1] suggest that this behaviour does not qualify as a test of causal intervention, as the birds learned about the causal relationship through immediate body contact, not from ‘observational information alone’.

To us, the difference between their and von Bayern et al.’s [2] design is not obvious: both causal chains were initiated by the crows’ actions, and the crows could observe the downstream effects. More importantly, the authors fail to
mention that two naive crows in the same study learned to nudge stones into the tube leading to the platform, after which they reliably dropped stones onto the platform. According to Taylor and colleagues’ view, this would be a case of causal intervention, as the crows had no direct experience of the collapsing platform. Their crows stopped pulling the food and started pushing the block directly after an average of 11 observation trials. This reinforced behaviour of pushing the block clearly resembles the reinforced behaviour of nudging stones as done by corvids in previous experiments [2,3]. Furthermore, the transfer from pushing a platform to dropping stones requires some understanding of affordances, and it involves novel stimuli and actions. It therefore seems to be more cognitively demanding than the transfer from nudging to dropping stones, in direct opposition to Taylor and colleagues’ claim.

In another study not mentioned by the authors, rooks had been trained to nudge stones into the same type of apparatus; they subsequently picked up stones and dropped them into the tube, similar to the two crows. Most importantly, one rook was able to drop a stone into the apparatus on her first trial, after having only observed her mate nudge and then drop stones and having never experienced the required actions or objects beforehand [3]. This meets Taylor et al.’s [1] conditions for causal intervention by observation.

Taylor et al.’s [1] methodology is in itself problematic; particularly, the comparison between crows and infants. While the infants were first encouraged to insert the marble into a marble run, which may have increased the likelihood of their inserting objects in the following test, the crows were not provided with such experience. Wild crows insert stick-tools into crevices but do not drop them; and they drop nuts onto hard surfaces, but this does not constitute tool use; whereas—in this experimental context—dropping a stone does. The infants were probably also more familiar with behaviours such as inserting and dropping objects into boxes, and they were more likely to have encountered hidden causes and mechanisms like the revolving cylinder. It would be informative to see whether infants from cultures with different levels of technology are equally successful.

It is also possible that the complexity of the experimental set-up proved confounding for the birds. In the experiments discussed above, the apparatuses were simpler: they did not involve revolving cylinders or ineffective holes, and the objects were probably easier to handle. The effective hole in Taylor et al.’s [1] experiment looked perceptually different from the others because of a ledge supporting the block—making it unsuitable to control for associative learning, because it could serve as a stimulus indicating the correct opening. Furthermore, the effective hole was always in the same position, but should have been randomized if it were to function as a control. In our experience, it is unclear how well corvids see through transparent apparatuses, and it seems that their performance is often increased by making them partially opaque, although this should be tested experimentally.

The theory that Taylor and colleagues present also has some limitations. First, they stress the importance of intervening on causal structures; but their view differs from other interventionist accounts, making interpretation unclear. Such interventions are important in what Woodward [4] calls difference-making accounts of causation, according to which the most important thing about causes is that they make a difference for their effects; i.e. their presence or absence influences the likelihood of the effect occurring. Smoking is a cause of lung cancer, because it increases the incidence of cancer compared to not smoking. By contrast, mechanical–geometrical accounts of causation—which are more popular among animal-cognition researchers—connect causes to effects through physical interactions. A typical example is one billiard ball colliding with another, causing it to move. All instances of causation can be expressed in difference-making terms, but not necessarily in mechanical–geometrical terms—at least not directly (consider historical causes). Taylor et al.’s [1] experiment can be described by either account: the object makes a difference for the dropping of the food, and it forces the cylinder to rotate, which in turn causes the food to fall. That said, interventionist approaches are typically regarded as difference-making accounts: one intervenes to change the value of an effect, regardless of physical principles involved. The possibility that the infants are more familiar than the crows with rotating mechanical parts and transparent objects could lead to the incorrect conclusion that they understand the difference-making aspects better. One solution might be to test subjects on an opaque apparatus, which also removes a variable—the cylinder—from the causal chain. Such a set-up might require less attention during observation trials for learning how the object makes a difference towards getting the reward, unconfounded by mechanical intermediates.

Furthermore, the authors claim that there is an important difference between observing and experiencing causal relations. In the former case, an agent sets something in motion, after which he observes the downstream effects—such as dropping an object on the cylinder or platform. In the latter case, the agent becomes part of the causal interaction directly by, for instance, pressing the platform. However, this seems to be an arbitrary distinction, reflecting different levels of analysis. Both cases can be formulated in terms of a direct cause–effect relationship (i.e. pushing the platform and dropping the stone result in food being dispensed) and in terms of a causal chain (i.e. pushing the platform and dropping the stone result in a force great enough to trigger the platform, causing it to fall, which causes the food to drop). In both cases, the crows both observe and experience, which makes the distinction hazy.

The authors have another reason for their distinction: learning a causal interaction through one’s own actions might constitute operant conditioning and thus cannot be a form of causal understanding. While this is true, the same can be said about classical conditioning. Both are forms of associative learning. Whether something is learned by doing or by observing is—of itself—irrelevant to whether it can be labelled causal learning.

Even if this were a critical difference, the crows in Taylor et al.’s experiment initiated the causal reaction themselves. Agency separates the three sources of difference-making information [4]: egocentric causal learning (e.g. shaking a branch because it results in fruit falling down), agent causal learning (shaking a branch to get the fruit because another agent did so) and observation/action causal learning (learning about the branch–fruit relationship through non-agent contingencies such as the wind blowing). The crows in Taylor and colleagues’ experiment were in an egocentric causal learning situation, for which it appears irrelevant.
whether or not the effect is caused accidentally, except for more detailed interpretations that involve elements such as the structure and explicitness of causal representations [4]. By contrast, the rook that immediately dropped stones after observing her mate seems to be an agent causal learner [3].

Dropping stones into a tube after previously only having experienced pecking the platform is a causal intervention, albeit an egocentric one. The same can be said for the other studies discussed here. This might be less advanced than agent or observation/action causal learning; but several different experiments have now shown that corvids can make novel causal interventions.

Researchers should indicate clearly whether they are investigating causal understanding in difference-making or mechanical–geometrical terms. Future research should address whether animals are agent causal learners or can learn from natural contingencies, and whether they can intervene on more complex causal models that involve multiple variables. Disregarding the mechanical–geometrical aspects of causal tests might show a more advanced causal understanding in corvids, and other animals, than previously known.

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References


