No conclusive evidence that corvids can create novel causal interventions

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Jacobs et al. [1] raise some interesting and important questions about our recent paper in which New Caledonian crows were unable to design a novel causal intervention [2]. These concern the problematic nature of animal/human comparisons, the complexity of our apparatus, other evidence that suggests corvids are capable of novel causal interventions and differing conceptions of causal understanding. We agree that comparisons of children and animals are often confounded because of the experience children gain from living in a highly technological world. Cross-cultural human studies would make comparisons between humans and animals more robust. At present, however, given the data we have, there does appear to be a clear difference in the ability of children and New Caledonian crows to create a novel causal intervention.

Jacobs et al. suggest the complexity of our apparatus obscured the causal nature of the task for our crows. Assessing the complexity of a task is difficult to do objectively. Is a visibly rotating drum really more complex than a platform help up by a hidden magnet—the apparatus used in past studies [3,4]? Jacobs et al. suggest this issue could be addressed by making the apparatus opaque, thus removing access to any mechanical information about the link between block and food. The argument that presenting less causal information would actually increase causal understanding is novel, and certainly one that is open to empirical study. A priori it seems unlikely that presenting information on both contingency and the mechanics of the task would hinder an agent’s understanding. The past work the authors cite as evidence of a causal intervention presented both types of information [3,4]. Thus for our present study, if the crows had failed without the presentation of both types of information, it would have been difficult to draw conclusions about their ability to create a causal intervention.

Jacobs et al. claim that the crows struggled to see into the Perspex apparatus and that our control was not functional because the effective hole had a ledge on its inside. There is good evidence that these crows, and other corvid species, have no problem seeing through transparent tubes and apparatuses [5–8]. While the presence of the ledge on the inside of the effective hole created a small perceptual difference, stimulus generalization predicts the crows should have treated all the holes in a highly similar if not identical fashion [9], particularly in a species that has been shown to be highly capable of generalizing across perceptual features [5]. Importantly, this control rules out the successful solution of the task arising from highly scaffolded trial and error learning on the white block the crows needed to drop into the apparatus in our experiment. That is, in both the Von Bayern and Bird studies [3,4], there was only one course of action available to the birds, namely to try out behaviours on a stone that the birds had previously been rewarded for interacting with. This could have helped scaffold the target stone dropping behaviour, particularly as putting the stone down the tube moved it closer to the food. Thus manipulating the stone to get it as close to the food as possible may have led the bird to accidentally drop the stone. This alternative explanation needs to be ruled out before we can conclusively claim that corvids are capable of novel causal interventions.

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This brings us to the authors’ central claim, that previous studies [3,4] provide conclusive evidence that corvids can indeed create a causal intervention. The field of animal cognition is plagued by the ‘many to one problem’—many different cognitive mechanisms can underpin a single behaviour. Just because an animal’s behaviour fits with the description of egocentric causal intervention or an agent-centric causal intervention, it does not follow that they actually have what philosophers call a ‘difference-making’ concept of causation [10].

There are other competing hypotheses for the cognition producing these behaviours. As outlined above, given that only one realistic course of action was available to the crows, one possibility is scaffolded trial and error learning, and generalization from rewarded behaviours to other, similar behaviours. The question concerns what is being learned. If we take Bird and colleagues’ results as an example, through nudging a stone towards a hole to release a reward, many things can be learned. One possibility, for example, is that the birds learn to touch the stone with their beak and move it towards the hole. Through repeated exposures and variation in how the stone is touched (nudged by the top of the beak, held within the beak, etc.), this may evolve into picking up the stone and dropping it (instrumental learning and generalization). Another possibility is that the birds learn that the platform needs to be dislodged by the stone, and therefore the stone must be dropped onto the platform (underpinning a causal intervention). The issue is that depending on the speed and nature of learning, these two different approaches could look identical to the outside eye: when we say that learning is gradual, we do not mean necessarily that it is slow. Our study was designed specifically to test between these hypotheses by manipulating the availability of the interim steps. One group (the instrumental group) had the opportunity to gradually alter their behavioural response so as to let it evolve towards the point at which they picked up and dropped the object into the correct hole. The other group were denied these interim steps. They had a single available interaction with the block (pushing/pecking) in a specific context (balanced on the ledge) that would lead to the reward, and then were presented with the block on the floor, demanding a novel behavioural response straight off. Going back to our previous available hypotheses, only the latter explanation—that of understanding the causal properties of the problem—would allow the bird to then pick up the object and insert it into the correct hole. The difference is subtle but crucial. When two types of learning can produce identical behaviour, it is necessary to manipulate the learning environment so as to aid differentiation between these alternative explanations.

The transition from beak pushing to stone dropping described by Von Bayern et al. [3] can also be explained by scaffolded trial and error learning. That is, the crows could have interacted with the stones simply because in the past interacting with the objects close to out-of-reach food led to reward. There is also another alternate explanation for this transition. This involves the extension of the bird’s reach: holding an object in the beak allows the crows to act on objects further away. The crows could therefore have picked up the stone and inserted it into the tube in an attempt to extend their reach. When this did not work, they could have dropped the stone either out of frustration or by accident, which would have led to the creation of stone dropping behaviours, as the stone was already positioned inside the tube.

One way to test between these hypotheses, and the hypothesis that an animal has a difference-making concept of causation, is to test for interventions where there is no reinforcement history tied to the specific objects and apparatus being used. Our experiment was set up to do this [2]. We gave the crows no direct experience of the rotating platform and no direct experience that putting the block into the hole led to reward. If corvids are truly able to create a causal intervention, the removal of direct reinforcement should not have led to failure. However, the crows did not succeed. Our operant group, who received training very similar to that received by birds trained to nudge stone into holes in past studies, did succeed, illustrating the crucial role reinforcement plays in the generation of novel behaviours in corvids.

In contrast to our findings, Jacobs et al. point to the behaviour of a single female rook, which appears to have been capable of creating a causal intervention without a prior reinforcement history via agent causal learning. This is an interesting anecdote, which could be explained by imitation, emulation or the ability to create a causal intervention from observation of another agent. Testing with and without a demonstrator would be needed to understand the cognitive underpinnings of this behaviour, as would replication in more than one subject.

In summary, the evidence that corvids understand novel causal interventions is at best ambiguous. Multiple competing hypotheses about the cognition underpinning the observed behaviours need to be ruled out before we can infer the use of more complex cognition. Our focus on observing, rather than experiencing causal relations is neither ‘arbitrary’ nor ‘hazy’, but rather provides experimental clarity: a novel behavioural sequence created without prior reinforcement history qualifies as a clear test for a difference-making concept of causation. This distinction should help guide future experiments in this area: if an animal can simply observe a causal relation and then generate a novel motor sequence that takes advantage of this relation, it is clearly operating outside of the bounds of both operant and classical conditioning. Carefully controlled experiments based on this distinction will create real progress in this area because they allow for the strong interpretation of potential intervention behaviours. By contrast, egocentric causal interventions appear so closely tied to operant conditioning [10] that work focused on this type of causal intervention is likely to generate a great deal of debate but little progress, owing to the many alternative ways of interpreting such results. This is neatly exemplified by our current debate with Jacobs et al.

References


