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Perspective Piece 3

Do New Caledonian Crows Represent <*weight*>? An Analysis of Jelbert et al. (2019)

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In this essay, I use the method offered by Povinelli (2020), to analyze a recent study by Jelbert et al. (2019) claiming to have assayed higher-order reasoning in New Caledonian crows. They argue that their crows displayed evidence of "making inferences about the properties of objects in the world around them, without having to directly experience those properties themselves" (p. 7). They further claim that these crows can perceive weight as a causal force, stating that "some researchers… argue that only humans are capable of representing weight as a causal mechanism; however, our results suggest this is not the case" (p. 7). But does their experiment reveal higher-order representations of <*weight*>, or does it implicate only first-order representations of weight such as effort-to-lift and effort-while-lifting (see Povinelli, 2012; Povinelli & Henley, 2020)?

In Jelbert et al.'s experiment, wild-caught New Caledonian crows were trained to pick up objects and drop them into a tube. Half of the crows were rewarded for dropping heavy objects, and the other half were trained for dropping light objects. Because the results in both groups were comparable, for simplicity I will hereafter refer only to the group trained to drop heavy objects. After successful training, these crows were shown two new and visually distinct objects—one heavy and one light—both suspended by strings, but they were not able to touch them. A fan was then turned on, which caused only the light object to move in the breeze. The objects were then removed from the strings and presented to the subjects. On the first trial, the crows showed a statistical bias for selecting the heavy object. Jelbert et al. claim that this bias provides evidence for higher-order causal reasoning about <*weight*> in their crows. I disagree.

Reimagining this experiment can help identify the problem. Consider replicating Jelbert et al.'s (2019) experiment with a slight modification: instead of seeing the objects moving in a breeze, the researchers allow the crows to peck at the strings. The objects are then removed from the string as before and the subjects are allowed to choose an object. One would properly object to the experiment, arguing, "Of course they chose the heavy one, they just received perceptually-based effort-to-lift information for both objects!" Indeed, Jelbert et al. explicitly state (p. 4) that they did not allow the crows to touch the objects as they dangled from the strings, knowing that this would have fatally compromised the study. But if a single instance of yanking on the strings fatally compromises the experiment, we are forced to ask, is it possible that the wild-caught crows in Jelbert et al.'s experiment never had such experiences?

The connection between spontaneous movement-in-a-breeze and effort-to-lift is something all wild caught crows must have experienced. Every object that a crow can lift is also subject to being dislocated by wind. Indeed, many objects vital to a crow's natural ecology, such as nesting materials (leaves, twigs, straw) and food resources (insects, nuts, berries), are extremely subject to wind force. To reiterate, it would be naive to claim that these crows have not encountered untold instances of the relation between high and low *effort-to-lift* and whether these objects move and or do not move spontaneously[1] —both within their lifetime and throughout their evolutionary history.

Indeed, when one observes wild crows, they see many instances of, for example, these birds chasing objects blowing away in the breeze. A personal experience comes to mind. One day I saw two crows chase the same plastic grocery bag before one picked it up and took flight. Curiously, I observed this phenomenon again (several times) within a training video of the Jelbert et al. (2019) experiment (three short videos were kindly provided to Daniel Povinelli and myself by the authors). On one trial, a crow named David landed in front of the heavy and light objects and chose the correct (heavy) object. Immediately after this, David took flight. The air movement generated by his wings blew the light object (the incorrect choice) off the table. Similar events occurred twice more, where the object was not completely blown off the table but still moved. Therefore, even within the limited sample of videos reviewed, David had indisputably observed the differential effects of air movement on heavy and light objects. Thus, by their own reasoning, this interaction constitutes a fatal flaw. The more important point is this: lab or wild crows must have innumerable experiences of this sort before they are tested.

Here then, is my best attempt at reconstructing the inductive argument Jelbert et al. (2019) are making, with the logical weaknesses identified:

P1 When presented with iterative two-object sets, with one in every pair requiring high *effort-while-lifting* and one with low *effort-while-lifting*, wild-caught New Caledonian crows learn to reliably choose the object with high *effort-while-lifting*.
P2 After training, when two new objects, one that moves in a breeze and one that does not, are presented to the crows visually, they can detect the difference in their motion.
P3 The only way crows could immediately pick the heavy one is if they possess the higher-order representation, <*weight*>.
P4 The crows choose the heavy object.
C Crows possess the higher-order representation, <*weight*>.

Logical weakness: P3 assumes the conclusion.

Next, I present a better version of their argument, including what I believe are suppressed premises (presented in bold):

P1 When presented with multiple two-object sets, with one in every pair requiring high *effort-while-lifting* and one with low *effort-while-lifting*, wild-caught New Caledonian crows learn to reliably choose the object with high *effort-while-lifting*.
P2 Wild-caught crows have had innumerable experiences wherein objects with varying degrees or spontaneously displacement and *effort-while-lifting*.
P3 *Effort-while-lifting* physiologically programs *effort-to-lift*.[2]

[1] I write "spontaneously" because Jelbert et al. (2019) did not demonstrate that the air movement generated by the fan had any effect on the crow's behavior—they assumed it. However, nothing in my analysis hinges on the fact of the matter. Even if the authors re-ran the study with a control condition that showed the main effect *was* dependent on the air movement (i.e., fan on/fan off, objects move identically in both cases), this would show only that the crows were sensitive to another first-order relation based on prior experiences.

[2] Although this is assumed by Jelbert et al. (2019) (see above), it should be noted that humans and other animals are known to possess an internal programming framework that codes for expected lifting values (*effort-to-lift*) based on

P4 When presented with objects that spontaneously move or do not move, crows trained to pick objects with high *effort-to-lift* select the object that did not move.

C1 The crows possess a perceptual representation of the relation between *effort-to-lift* and *spontaneous-displacement-of-objects*.

C2 The crows possess the higher-order representation, <*weight*>.

Logical weakness: The capacities referenced in C1 are necessary and sufficient to produce the results, therefore C2 is unnecessary.

Is it possible to argue that despite innumerable opportunities to form such first-order relations, the experiment is still valid? It may be tempting to think that because Jelbert et al. (2019) used "novel" objects in the testing phase, this somehow implicates higher-order reasoning. Indeed, these "novel" objects spanned a wide range of shapes and textures, none of which are readily found in nature. But visual information is not the perceptual dimension this experiment hinges upon. In fact, birds were initially trained to ignore visual information and to make their choice based solely upon *effort-while-lifting*. Thus, the dimension of object novelty highlighted in the title of their report was irrelevant to the crows' decisions, and consequently irrelevant to a proper interpretation of the experiment.[3]

The lesson here is not about this specific experiment. It is about this type of experiments. By definition, designs like this inescapably grant the subjects first-order perceptual relations, while trying to test for higher-order ones. Due to higher-order concepts (in this case, <*weight*>) being inherently unobservable, experimenters must provide stimuli that link to internal perceptual representations (in this case, high *effort-while-lifting*/*effort-to-lift* leads to food reward). And while these experiments may (in a narrow sense) present subjects with objects or events never-before-encountered, the relevant, abstract perceptual information must be present in the stimuli (see Povinelli & Henley, 2020).

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even a single event of *effort-while-lifting* (see, e.g., Povinelli, 2012, Exps. 1-8). Indeed, it would be difficult to make any assumptions about higher-order representations of <*weight*> within the crow without admitting such first-order relationships.

[3] *Note by DJP*: I add the following note to Ty Henley's careful analysis. The crows in the Jelbert et al. (2019) experiment may have demonstrated a greater facility at building relations between *effort-while-lifting* to *effort-to-lift* than our chimpanzees demonstrated in *World Without Weight* (Povinelli, 2012, see especially Experiments 10-11). This would not be surprising given the enormous energetic expense associated with translocating the mass of objects during flight. In fact, we predicted it:

> The picture that emerges is that … [weight-sorting] … is a difficult task for apes and other primates to learn. Why? One speculative possibility is that there will be some species in whom evolution has acted to use weight/force-related signals to modulate complex actions on objects in specific contexts (i.e., birds who transport objects for nesting material). It seems quite possible (although by no means necessary) that these species might perform exceedingly well on simple weight-sorting tasks (like the one employed here) but still exhibit no general representation akin to [<*weight*>] (p.98).
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> ...birds may be an even more interesting case in this regard. Feathered flight is an energetically extreme form of location and therefore avian species ought to be extremely sensitive to the embodied representation of weight involved in activities such as trans- porting nesting materials. Thus, it is easy to speculate that evolution may have sculpted the neural systems of birds to track *effort-while-lifting* for goal-directed purposes (p. 323).

I end with two questions. First, if first-order relational reasoning is both necessary and sufficient to explain the results of these and all other experiments in the experimental genre, does this imply that first-order relational reasoning is also necessary and sufficient to survive in the wild? Second, and related, could the focus on higher-order reasoning in these experiments be distracting us from understanding animals as they truly are?

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