Dual systems for all: Higher-order, role-based relational reasoning as a uniquely derived feature of human cognition

Daniel J. Povinelli[a], Gabrielle C. Glorioso[b], Shannon L. Kuznar[a] and Mateja Pavlic[b]

[a]Department of Biology, University of Louisiana, Lafayette, LA 70504 and [b]Department of Psychology, University of Louisiana, Lafayette, LA 70504.
povinelli@louisiana.edu C00304772@louisiana.edu
shannon.kuznar1@louisiana.edu mxp1503@louisiana.edu
www.danielpovinelli.com

doi:10.1017/S0140525X19000451, e271

Abstract

Hoerl and McCormack demonstrate that although animals possess a sophisticated temporal updating system, there is no evidence that they also possess a temporal reasoning system. This important case study is directly related to the broader claim that although animals are manifestly capable of first-order (perceptually-based) relational reasoning, they lack the capacity for higher-order, role-based relational reasoning. We argue this distinction applies to all domains of cognition.

Hooray for Hoerl and McCormack's (H&M's) project on temporal cognition (TC). Their distinction between "temporal updating" (TU) and "temporal reasoning" (TR) adeptly demonstrates the sufficiency of the lower-order system, TU, to explain the TC of animals. To modify a trope from Dan Dennett: *In order to keep perfect track of the changing states of affairs in the world, it is not requisite to know a thing about time* (see Dennett 2009, for a discussion of Charles Darwin and Alan Turing's similar and respective "strange inversions of reasoning").

Povinelli and colleagues have previously shown that H&M's analysis, *mutatis mutandis*, holds true across most (if not all) other domains of cognition (Penn et al. 2008). Their "reinterpretation hypothesis" (RH) was initially advanced to explain the evolution of social cognition, and its central claims tightly parallel H&M's account of TC (Povinelli & Giambrone 1999; Povinelli & Vonk 2004):

1. Human social cognition is composed of phylogenetically ancient mechanisms for reasoning about behavior (analogous to those that H&M describe for the TU system), and a uniquely human system that reinterprets those behavioral relations in terms of abstract mental states.
2. The two systems continue to operate in concert in modern humans.
3. The newer system is dependent on the older one, but the causal power of the older system can completely explain the results of tests with animals.
4. Because of (3), RH is not an ad hoc alternative to higher-order accounts of animal social cognition.

The RH was later extended to other domains of cognition, including concept formation, physical causality (tool use), reasoning about weight, and even TC (Povinelli 2000; 2012; Vonk & Povinelli 2006). Finally, Penn et al. (2008) specified the domain general format of the RH, arguing that the ability to cognize over higher-order, role-based analogical relations is a uniquely human capacity cutting across every domain of cognition.

In this view, "time" is one of myriad, higher-order relations the human mind constructs. The bedrock distinction of TR is the ability of humans to group innumerable (indeed, any) individual perceptual relations (leaves falling, sands running through an hourglass, gray hairs erupting on one's head, etc.) as *temporal* relations. H&M note that the human naïve (or folk) theory of time is yet to be fully explicated, and offer the interesting claim that one feature might be the idea that time "flows." This may be true, but all human babies share the capacity to be enculturated into any theory of time (scientific or otherwise). Why? Because the human mind allows for disparate perceptual relations to be grouped under common thematic or argumentative roles—a hallmark signature of all higher-order, role-based relations (Penn et al. 2008).

Since the most general statement of the RH was published in the pages of this journal a decade ago, dozens of empirical studies with animals have challenged the view that only humans reinterpret first-order perceptual relations in terms of higher-order relations. But all the demonstrations we have examined suffer from the same logical limitation that Povinelli and colleagues (and herein, H&M) have identified—namely, that first-order relational reasoning is necessary, but not sufficient for higher-order relational reasoning:

Same/different judgments?

Animals are presented with a sample of two (or more) objects that are either all the same (AA) or different (BC), and then can learn to select alternatives that match the relation (i.e., DD or EF). Are such performances evidence that animals possess the higher-order relations of *same/different* as some have claimed (e.g., Flemming et al. 2013)? No, because to form such higher-order relations, a cognizer must first detect the amount of perceptual variability in the displays (zero variability for *same*, higher variability for *different*). Once such perceptual variability is detected, however, this information can be used to sort novel exemplars.

Spatial analogies?

Haun and Call (2009) claim that chimpanzees can recognize relational similarity between perceptually distinct predictors of food location. Subjects were confronted with a tilted table that contained three equally spaced out beyond their reach ("far") cups and three within reach ("near") cups. The second and third near cups were increasingly spatially misaligned with the far cups. In one condition, opaque tubes connected the experimenter's cups to the subjects' cups. In another, painted lines "connected" them. The chimpanzees saw food dropped in a far cup and successfully searched in the near cups that were connected by the tubes or the lines. These apes were clearly tracking spatial relations (e.g., "if food is placed to extreme right, orient to that side" or "if cups are touched by a tube, pick it"), but there is no reason to think they constructed an analogy between the spatial relations of lines and tubes as suggested by the authors. Christie et al. (2016) recently claimed that chimpanzees are sensitive to the spatial analogy between a three-tiered shelf and another, identical one located nearby. While this is evidence that space guides searching ("food located low, continue to search low"), it is a far cry from higher-order relational reasoning.

Analogy in tool use?

Taylor et al. (2007) demonstrated that crows use a short stick to retrieve a longer, functional stick. They suggest the crows may have done so by cognizing over the causal analogy between short and long sticks ("tools access out of reach objects"). This task may or may not be "cognitively demanding," but it can certainly be solved by detecting the spatial distance between the subject and the goal object and the length of the stick.

Theory of mind?

Bugnyar et al. (2016) showed that ravens that hear (but do not see) a conspecific in an adjoining room are sensitive to the presence/absence of a small hole in the wall between the rooms. They interpret this as evidence that the subjects can imagine the mental state of the other raven *seeing* them. This experiment was designed to rule out the deflationary account of previous studies, wherein animals need only track and use the relations between conspecific location and unobstructed geometric paths. But there is nothing higher-order about an organism constructing a geometric relation based on "hearing" (as opposed to "seeing") a nearby conspecific.

A flood of additional claims for higher-order thinking in animals have surfaced on topics such as the appearance-reality distinction, metacognition, intentional communication, water displacement, logical inference, false beliefs, love, morality, maps, gravity, altruism, mourning the dead, self-recognition, teaching, cooperation, and physical cognition (Povinelli & Barker 2019). We contend each of these claims can be dismantled in the manner that H&M have for TC, and we have done for other cognitive domains.

Given that such a straightforward issue lies at the heart of innumerable confusions in animal cognition (Penn & Povinelli 2009), why is it consistently ignored by comparative psychologists? While we encourage others to remain hopeful that H&M's master class on TC will lead to a sudden sea change, we remain cautious. Is there something so folk-psychologically compelling about tales of higher-order thinking in animals that even scientists cannot escape them? If so, comparative psychologists may well go on telling such animal tales as long as humans go on telling stories (Barker & Povinelli 2019). H&M's heroic efforts would then be destined to sink into the mythic sea of "lost knowledge"—that ever-receding ocean of hard-won truths humans are fated to continually rediscover.

Locating the contradiction in our understanding of time

Simon Prosser

Department of Philosophy, University of St Andrews, St Andrews, Fife KY16 9AL, United Kingdom.
sjp7@st-andrews.ac.uk
www.st-andrews.ac.uk/philosophy/dept/staffprofiles/?staffid=110

doi:10.1017/S0140525X19000529, e272

Abstract

I offer some clarification concerning the kind of contradiction that Hoerl & McCormack's account could help explain and the scope of the metaphysical intuitions that could be explained by such a theory. I conclude that we need to know more about the sense in which the temporal reasoning system would represent time as a dimension.

Hoerl & McCormack (H&M) say that "there is an inherent contradiction in people's naïve theory of time, insofar as it contains within it both the belief that there is an objective present and the belief that which moment in time is objectively present changes" (sect. 4, para. 6). They suggest that their two-system account helps explain this. But although I think there is something to be said for their proposal, the contradiction that they explain is different from the one that they say they are going to explain.

The latter contradiction arises because of the alleged conflict between the claim that the present time has a unique, privileged status and the claim that every time momentarily becomes present as time passes. It cannot be true that all times are present, and that only one time is present. As H&M suggest, this is one way of capturing the contradiction that J. M. E. McTaggart (1908) suggested lay in the very notions of past, present, and future.

There is a standard response: No contradiction arises in our naive view because, according to that view, only one time is present *at any given time*. H&M say that this reply fails because "it makes which moment in time is present dependent on what time it is considered from, rather than it being an objective property of time which moment is present" (sect. 4, para. 7). But this reply would not satisfy the advocate of the naive view. For they hold that when time passes, reality, as a whole, changes; a different time becomes present. This change does not correspond merely to a difference in perspective; it is an objective change in reality. No two times are present within a single reality, so there is no contradiction.

The contradiction that H&M subsequently explain does not, however, appear to be the one whose existence I have just denied. Instead, it is a contradiction between the claim that there is just one moment in time, with past and future times not being real, and the claim that all times are equally real. This does not concern presentness; it concerns ontology, or what exists. Their suggestion is that because the temporal updating system represents only the present time, and deals with changes just by updating its model of the present, it disposes us to think that the content of the model is all that is real. The temporal reasoning system, by contrast, represents the whole time series, and therefore drives the intuition that all times are real.

It is worth mentioning some relevant theories in metaphysics. According to *presentism*, reality is not extended in time, and consists only of the present, whose features change as time passes. So the temporal updating system would embody the presentist view of reality, and explains the intuition that drives it. According to *eternalism*, by contrast, reality is extended in time, and all times are equally real. The temporal reasoning system therefore models an eternalist metaphysics.

Not all eternalists deny that time passes, however. Some, known as *moving spotlight* theorists, hold that each time undergoes constant changes in the extent to which it is past, present or future. The fact that such views are possible, and sometimes advocated, must cast some doubt on whether the two-systems theory can explain the sense of time passing, rather than explaining just the ontological intuition that only what is present is real (though this would still be progress).

Presentists do not deny that there are truths about the past or future. They typically hold that reality should be described using the operators of tense logic, such as 'in the past.' Hence, the past occurrence of rain is represented as 'in the past: it is raining.' This corresponds to one version of our naive view of time: Only the