Animal minds in time: the question of episodic memory

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In his book *Matter and Memory*, Henri Bergson writes:

> When a dog welcomes his master, barking and wagging his tail, he certainly recognizes him; but does this recognition imply the evocation of a past image…? [The] past does not interest the animal enough to detach it from the fascinating present […]. To call up the past in the form of an image, we must be able to withdraw ourselves from the action of the moment, we must have the power to value the useless, we must have the will to dream. Man alone is capable of such an effort. (Bergson 1911: 93f.)

Bergson's words evoke a trope that can be found in the works of philosophers as diverse as Aristotle (1930, 453a4-13), Friedrich Nietzsche (1983, p. 60f.), and Daniel Dennett (2005, p. 168f.). The idea is that there is a deep discontinuity between us and the rest of the animal kingdom when it comes to the role of time in our mental lives: non-human animals are, in some sense, cognitively stuck in the present. This idea has recently received fresh attention, and is now typically framed in terms of the question as to whether animals are capable of having *episodic memories* (Tulving 2001). The thought, in short, is that the human capacity to consciously recollect particular past events constitutes an important way in which we can cognitively transcend the present. As it is sometimes put, it constitutes a form of 'mental time travel'. And the question is whether non-human animals, too, are capable of mentally transporting themselves to another time in this way.

1. A background issue: the question of function

Bergson's remark about "the power to value the useless" was perhaps not meant entirely literally. It can more plausibly be seen as a rhetorical device aimed at drawing attention to a key issue in the background of the question as to whether animals have episodic memories – the question of the *function* of episodic memory. Much human reminiscing about times gone by seems to serve no useful practical purpose. And even when episodic memories contain useful information about events or situations of a type we may encounter again, this information could arguably equally well be carried by other forms of memory, in which only generic knowledge is retained. So there is a genuine question as to whether there is ever any specific point to being able to cast one's mind back to a particular past event as such, given that *that particular event* will never come round again.

If there is no easily identifiable distinct adaptive function that episodic memory can be seen to serve, this obviously also makes it difficult to come up with experimental paradigms that hold the potential to yield unambiguous evidence of the presence of episodic memories in animals. It is therefore a hopeful sign that the question of the function of episodic memory has recently moved into the forefront of attention in the context of research on 'mental time travel' more generally conceived, which views episodic memory as part of a larger functional system that also includes capacities for specific forms of future directed thinking (Boyer 2008; Hoerl & McCormack 2016; Klein 2016; Schacter et al. 2007). A clear consensus has yet to emerge from this literature as to how precisely the function of episodic memory is to be construed, but we will briefly mention one particular suggestion at the end of this chapter.

For the moment, one important thing to note is that what we are calling the question of function, as we understand it, is not answered by saying that episodic memory is memory for particular past events, or that it involves the retention of information, as it is sometimes put, about 'what' happened, 'where' and 'when'. For that just raises the question of function again, i.e. the question as to what the benefit is, to the individual, of being able to retain such information. This point, we believe, sometimes gets lost in what has perhaps been the predominant strand of debate in the recent literature on animal episodic memory. As a result, even though there remains deep disagreement on the question as to whether animals can be credited with episodic memory, there is in fact something of an unhealthy consensus regarding the way the terms of the debate are framed. As we discuss in more detail below, it is typically assumed on all sides that certain animal experiments have successfully demonstrated that animals can retain information about 'what', 'where' and 'when', and debates have mainly focussed on whether this is sufficient to also demonstrate that they possess episodic memory. We want to make a case for shifting the focus of the debate elsewhere.

2. Is "the only thing missing" evidence of conscious phenomenology of recollection?

It is a series of studies on scrub-jays carried out by Nicola Clayton and her colleagues that is largely responsible for the recent surge of interest in the question as to whether animals have episodic memories (Clayton & Dickinson 1998; de Kort et al. 2005; Griffiths et al. 1999). Western scrub-jays are food-caching birds who have a strong preference for eating worms over eating nuts. But worms are perishable, whereas nuts are relatively nondegradable. Clayton and her colleagues exploited these facts in

creating a set-up in which a group of scrub-jays could learn that worms were still fresh 4 hours after caching, whereas they had decayed and become inedible after 124 hours. The jays were given opportunities on different occasions to cache either one or the other food source, and later to retrieve their caches. What the researchers found was that the birds were sensitive, at recovery, to how long ago they had cached the worms. If they had cached the nuts some time ago, and the worms just four hours ago, they tried to retrieve the worms. If they had cached the worms 124 hours ago, they tried to retrieve the nuts, leaving the caching site of the worms undisturbed.

In interpreting these findings, Clayton et al. (2003, p. 686) draw a contrast between, as they call it, "phenomenological and behavioral criteria for episodic memory", respectively, pointing out that much of the literature characterizing episodic memory in humans focuses on its distinct phenomenology as a conscious phenomenon. What they claim is that their study demonstrates that the jays can remember 'what' they cached, 'where', and 'when', thus providing behavioral evidence for memory that is, they say, at least 'episodic-like' in these respects, even though the study leaves open whether the jays also have the same phenomenology of mentally re-experiencing the past that humans enjoy when they recollect events in episodic memory.

Interestingly, this general analysis of Clayton and Dickinson's study is in fact *shared* by many of those authors who are skeptical about the existence of episodic memory in animals. In the view of the latter, the conscious experience of mentally re-experiencing the past is essential to episodic memory, and because it is not clear whether the jays have this experience, we lack evidence that they have episodic memory. Here for instance is Endel Tulving's assessment of the significance of Clayton and Dickinson's study:

> The ingenious and convincing demonstrations of the 'what, where, when' memory in scrub jays by Clayton and her colleagues come very close to clinching the case for the jays' episodic memory. The only thing missing is evidence that they have human-like conscious recollections of their worm and nut caching activities. (Tulving 2001: 1512)

Similarly, Thomas Suddendorf and his colleagues, who have been amongst the most vigorous defenders of the claim that episodic memory is unique to humans (Suddendorf & Busby 2003; Suddendorf & Corballis 2007), seem in agreement with Clayton and her colleagues regarding the basic dialectical situation, which they describe as having to define episodic memory either "in terms of the information encoded" (Suddendorf & Busby 2003: 392), or in terms of the phenomenology of travelling back in time, where these are seen as mutually exclusive options, because one "can know what happened where and when without being able to remember the event (e.g. your birth) and, conversely, one can travel back in time without access to accurate when and where information" (ibid.).

We believe that this is an unhelpful way of framing the dialectic of the debate over the question as to whether animals are capable of episodic recollection. Take, for instance, the stance taken by Clayton and her colleagues. Although they are not officially committing themselves either way, there are essentially two ways in which this stance might be fleshed out. Either it implies that it is indeed possible for animals to engage in much the same kinds of information processing as humans, but without the conscious phenomenology that accompanies it in humans. Or the view is that, because their study provides the best available evidence for animal episodic memory,

we should also accept that such memory is accompanied by the same phenomenology that accompanies human episodic recollection (Eichenbaum et al. 2005, explicitly take a position along those lines).

Note that if either of these was in fact the target view at stake in the debate, it would actually render it mysterious why it is the question of animal *episodic memory*, specifically, that is supposed to be of special interest in that debate. The first view just described effectively relies on something like the philosophical 'zombie hypothesis' in the literature on physicalist approaches to consciousness, according to which it is possible for an organism to show exactly the same behavior as a conscious human being, but without enjoying any conscious phenomenology. Conversely, on the second view, it is those who question the existence of animal episodic memory who are effectively portrayed as relying on something like this hypothesis. But the zombie hypothesis is a completely general skeptical hypothesis, covering all forms of activity that typically involve conscious awareness in humans. So it is unclear what the dialectical benefit would be (to either side) in trying to invoke it to make a point specifically about episodic memory.

We believe that the existing focus on a supposed dichotomy between information-based and consciousness-based approaches to episodic memory anyway misrepresents some of the arguments that are being made, including arguments by some of the researchers who subscribe to the idea of such a dichotomy. As we want to argue, what should really be at issue is whether it is even correct to describe Clayton and Dickinson's study as demonstrating the existence of a form of memory in which information about 'what', 'where' and 'when' is retained.

3. Being sensitive to time without representing the past

Somewhat contrary to their own claim that "[t]he current evidence suggests that scrub jays […] can encode, store and use information about *what* they cached *where* and *when*" (2003: 394), Suddendorf and Busby at one point also write that the cognitive processes governing the behavior exhibited in Clayton and her colleagues' studies "need not be *about* the past at all" (ibid., p. 392). Following Dretske (1982), they explain: "[E]vent A might cause cognitive change B that affects behavior C at a later point in time, but this need not imply that B carries any information about A itself – the mediator B might be causal rather than informational. Thus, although jays perform actions C (recovery) that make sense only in the light of A (caching what, where and when) it need not imply that B represents the past event A" (ibid.).

On the face of it, this would seem to be a way of arguing against the claim that Clayton and her colleagues have demonstrated episodic memory in animals that does not rely on considerations about phenomenology. Instead, it concerns what it means to say that an organism has information about or represents something. But how can we flesh out Suddendorf and Busby's remark further, to see how exactly the rather abstract thought they sketch might apply to this particular case? The jays studied by Clayton et al. are clearly sensitive to the temporal interval that has elapsed since they cached the worms. So what grounds might there be for thinking that they nevertheless do not represent the worm-caching event as lying at the far end of that interval, in a way that would warrant describing them as remembering 'when' the caching happened?

In general, we can distinguish between two quite different ways in which an individual's cognitive state might be sensitive to the passing of time. One of them involves explicitly representing events as happening at an array of different times. By

contrast, in what we have elsewhere referred to as *temporal updating* (Hoerl 2008; Hoerl & McCormack 2011; McCormack & Hoerl 2005), the individual just operates with a model of its *current* environment, which is updated in ways that are sensitive to the passing of time, but with each update simply replacing its predecessor. In its simplest form, such updating would consist in changing the model in response to new perceptual information that conflicts with the previous model. But temporal updating could also, for instance, explain certain basic forms of sequential learning. Becoming sensitive to the sequence in which a familiar set of events typically unfolds might simply be a matter of acquiring a routine for serially updating one's model of one's current environment, so that representations of the relevant events come to succeed each other in the right order in successive instantiations of that model.

So the general thought here would be that some forms of sensitivity to the passing of time can be explained by appealing to processes governing how the individual's model of the environment gets updated over time, where this is to be contrasted with the idea that temporal relations are themselves represented in that model. Is there also an explanation of the scrub jays' caching behavior available that relies only on the idea of temporal updating? Note that one thing that should be uncontroversial is that their behavior must, in part, be governed by a mechanism that can keep track of intervals of time. Unless we postulate the existence of some kind of internal interval timer that is causally responsive to the amount of time that has elapsed since the caching took place it remains mysterious how the jays can show differential behavior depending on the length of that interval. But, given that the behavior must be based on the use of such a timer, we can once again distinguish two different mechanisms by which its workings could influence behavior (see also McCormack 2001 and Hoerl 2008). One of these involves producing mental

representations in which the caching and the interval elapsed since figure – as implied by the idea of a memory for 'what', 'where' and 'when'. Yet, in line with the idea of temporal updating, there is also another, simpler, mechanism by which such a timer could have an impact on behavior, *viz.* by determining how long aspects of the individual's model of its environment will be maintained in existence. In other words, what the timer would determine is how long the presence of the worms (or worms-as-food) in their caching location would continue to figure in the jays' model of their current environment before disappearing from that model. It is in this sense that the processes governing the birds' behavior "need not be *about* the past", as Suddendorf and Busby put it.

4. Event-independent thought about times

If the considerations presented in the previous section are along the right lines, the crucial question they raise is how exactly human temporal cognition goes beyond mere temporal updating, and whether there is any evidence that can bear on the question as to whether animals, too, can engage in modes of temporal cognition that go beyond temporal updating.

Elsewhere, we have argued that one distinctive feature of mature human temporal cognition is that it involves *event-independent* thought about times (Hoerl & McCormack 2011; McCormack & Hoerl 2008), i.e. the idea of time as a framework of positions at which different events can be located. Episodic memory can be seen as one manifestation of such event-independent thought about times, in so far as it involves the ability to retain information about events that are no longer part of one's environment specifically by cognitively placing those events at other times. This arguably requires the ability to make those other times an object of thought in their

own right, rather than just retaining features of the events in question that might still be of relevance to how the world is now.

Thus, at least one important aspect of the question as to whether non-human animals have episodic memories is whether they can engage in event-independent thinking about time, rather than just relying on temporal updating. Is there any existing research that might help in answering this question? We will conclude by briefly considering two such lines of research, which may also help to clarify what exactly the question consists in.

One relevant line of research concerns the question as to whether animals can experience *regret*. As we have argued in more detail elsewhere, regret involves event-independent thinking about past times, and indeed one key function of episodic memory may in fact lie in underpinning the ability to experience regret (Hoerl & McCormack 2016). Regret is sometimes referred to as a *counterfactual emotion*, as it turns crucially on a grasp of the idea that what one did at a certain point in the past was not the only option available at that time, and that one's making a different choice might have led to a different, better, outcome. This also, arguably, means that regret involves the ability to think of the time when the past choice was made independently of thinking just of that choice and its outcome.

In order to investigate whether rats can experience regret, Steiner and Redish (2014) constructed a spatial decision-making task in which rats could sequentially visit four different food locations, each with a different kind of food. When entering each food location rats heard a tone that was gradually decreasing in pitch, with the pitch of the tone indicating the delay the rat had to wait until gaining access to the food at that location. The delays, lasting between 1 and 45 seconds, were selected

pseudorandomly, and if the rat left the location before the delay was over, the countdown stopped and the rat had to move on to another location for food.

After determining the rats' food preferences, and the threshold duration each rat was prepared to wait for each foodstuff on each day, the researchers analysed in particular those sequences in which rats abandoned waiting for one type of food even though the delay, on that occasion, was below the threshold for that type, and the delay for the next type of food then turned out to be greater than the threshold for that type. As they explain, this kind of sequence can be interpreted as one "in which the rat skipped a low-cost offer, only to find itself faced with a high-cost offer" (Steiner & Redish 2014: 998). This was compared with sequences in which the rat took the first, low-cost, offer, and then encountered a high-cost one, and sequences in which both offers were high-cost, and the rat skipped the first one, only to find itself faced with another high-cost one. As Steiner and Redish argue, these latter two control conditions are ones that might prompt disappointment or frustration, but, unlike the first, are not potentially regret-inducing, because the rat acts correctly, given its preferences and the relevant thresholds.

Steiner and Redish found that the rats treated the potentially regret-inducing sequences differently from each of the two types of control sequence. Specificallly, in the former, they "paused and looked backwards towards the previous option" (ibid.), which they had abandoned. This was accompanied by neurophysiological activity that corresponded to the missed action.

Steiner and Redish's interpretation is that the rats experienced regret at their past decision to leave the previous food location rather than waiting out the delay. This implies ascribing to them the capacity to turn their minds back to the past in quite a robust sense, i.e. to genuinely revisit a *past time* in their thinking, in so far as

they can think of it both as the time they made a certain choice, but also a time at which another choice, too, could have been made. This is an intriguing suggestion, particularly in the light of research that suggests that regret is a cognitively sophisticated emotion that is late-developing in children (O'Connor et al. 2012, 2014; Weisberg & Beck 2010). It is largely because of its counterfactual element that regret is viewed as cognitively sophisticated, and a key challenge facing a regret-based interpretation of animal behavior is to provide convincing evidence that the behavior in question is indeed underpinned by counterfactual thought.

In typical human studies of regret (e.g., Camille et al. 2004; Mellers et al. 1999) participants are faced with a choice (e.g., between a safe and a risky gamble in a trial of a gambling task), and at that choice point they do not know what outcome would result from the choice they could take but subsequently reject. Only once they have made their actual choice and have found out the outcome resulting from that choice are they provided with information about the outcome the rejected choice would have yielded, which on a regret trial turns out to be better than that of the actual choice. This makes it more difficult to explain the subsequently-reported negative emotion without appealing to participants entertaining a counterfactual about a past state of affairs (i.e., what would have happened if they had chosen differently), because participants' motivational state, experience, intention, and decision, are, up until that point, potentially identical to those in a control trial in which exactly the same choice is made but the actual outcome is better than or equivalent to the outcome of the other choice (and also to those in a so-called "partial feedback" trial in which participants never find out the outcome associated with the non-chosen option). This is not the case in Steiner and Redish's study, where the previous experience and presumably motivational state of the animal differs by definition across 'regret' and

control trials. This makes it somewhat harder to argue that the rats must be entertaining a counterfactual.[1]

The example of regret serves to demonstrate that focusing on the significance of event-independent thought about time is useful in broadening the scope of the studies that can be considered to be relevant to assessing animals' temporal abilities. We finish by describing a study that can be interpreted as examining another type of behavior requiring event-independent thought about time in a different species, i.e. great apes. Adapting a procedure first used by Beck et al. (2006) to test children, Redshaw and Suddendorf (2016) showed apes a forked tube apparatus with one opening at the top but two openings at the bottom and demonstrated that a grape dropped into the top opening could emerge from either bottom opening, it being apparently random from which it would emerge on each occasion. The apparatus was then moved closer to the apes, so that they had the opportunity to catch the grapes as they emerged from the bottom opening; otherwise, the grapes would roll out of reach. The experimenters found that none of a number of great apes they tested spontaneously covered *both* bottom openings on their first trial, and only one of them did so at all on the initial twelve test trials, but subsequently regressed to covering only one opening.

That apes fail this relatively simple task seems to point to a fairly basic limitation in the ability to think about the future. Specifically, what they seem to lack is the ability to apply the equivalent of the type of thinking about the past that we have argued is involved in regret. The grape dropped into the apparatus is clearly part

[1] It may be possible to design rat experiments that more closely resemble the human tasks in this respect, given the emerging body of research on the effects of entirely fictive rewards on animal behavior (Hayden et al. 2009; Kim et al. 2015).

of their model of the world, even after it has disappeared in the top opening, but it appears that they cannot think of the time at which it will emerge as a time at which it will emerge from one of the bottom openings, but at which it could emerge from either one of them. Thus, Redshaw and Suddendorf's study might be taken to be indicative of an inability to engage in event-independent thought about times, indicating instead that apes' cognitive abilities with respect to time are limited to mere temporal updating.

5. Conclusion

Are animals cognitively stuck in the present, or are they, like us, able to mentally revisit particular past events in episodic memory? In this chapter, we have made a case for shifting the existing focus of debate on this issue from considerations about the phenomenology of episodic recollection to the question as to whether there is evidence that animals are capable of event-independent thinking about times, or whether they a capable of temporal updating only. In temporal updating, there may be a variety of mechanisms by which the passing of time can influence the model of its environment that an individual operates with. Yet, this does not mean that time itself – the past and the future alongside the present – figures in that model. Episodic memory, by contrast, involves retaining information about events specifically by cognitively placing them at a past time. This, we have suggested, requires making that past time an object of thought in its own right, as one that could also have been filled with different events. As such, episodic memory is distinct from other ways of retaining or being sensitive to information over time not just in virtue of its phenomenology, but also in the way in which it is bound up with quite sophisticated

abilities to think about the possible as well as the actual, which remain to be demonstrated in non-human animals.

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Further reading

J. Bennett, *Rationality* (Indianaplois: Hackett Publishing Company, 1989) provides a thought-experiment intended to establish that "there is no non-linguistic way of manifesting knowledge of just some fact about one's past" (p. 88). Chapter 5 of T. Suddendorf, *The Gap: The Science of What Separates Us from Other Animals* (New York: Basic Books, 2013) critically reviews empirical work claimed to provide evidence for the existence of animal episodic memory. Less skeptical views about animal memory can be found in part 6 of K. Michaelian, S. Klein, & K. Szpunar (eds.), *Seeing the future: Theoretical perspectives on future-oriented mental time travel* (Oxford: Oxford University Press, 2016).