



Looking for episodic memory in animals and young children: Prospects for a new minimalism

Nicola S. Clayton*, James Russell

Department of Experimental Psychology, University of Cambridge, Downing Street, Cambridge CB2 3EB, UK

ARTICLE INFO

Article history:

Received 1 March 2008

Received in revised form 4 July 2008

Accepted 6 October 2008

Available online 17 October 2008

Keywords:

Episodic cognition

Animals

Children

ABSTRACT

Because animals and young children cannot be interrogated about their experiences it is difficult to conduct research into their episodic memories. The approach to this issue adopted by Clayton and Dickinson [Clayton, N. S., & Dickinson, A. (1998). Episodic-like memory during cache recovery by scrub jays. *Nature*, 395, 272–274] was to take a conceptually minimalist definition of episodic memory, in terms of integrating information about what was done where and when [Tulving, E. (1972). Episodic and semantic memory. In E. Tulving, & W. Donaldson (Eds.), *Organisation of memory* (pp. 381–403). New York: Academic Press], and to refer to such memories as ‘episodic-like’. Some claim, however, that because animals supposedly lack the conceptual abilities necessary for episodic recall one should properly call these memories ‘semantic’. We address this debate with a novel approach to episodic memory, which is minimalist insofar as it focuses on the non-conceptual content of a re-experienced situation. It rests on Kantian assumptions about the necessary ‘perspectival’ features of any objective experience or re-experience. We show how adopting this perspectival approach can render an episodic interpretation of the animal data more plausible and can also reveal patterns in the mosaic of developmental evidence for episodic memory in humans.

© 2008 Elsevier Ltd. All rights reserved.

About the most profound result of the conceptual revolution set in train by Endel Tulving’s introduction of the notion of episodic memory (Tulving, 1972) was that it revived the scientific study of experience, as opposed to behaviour and representation. This is because episodic memory is essentially the re-experiencing of a situation. Adult humans can, of course, report on their experiences and can indeed judge whether they simply know something or whether they can recollect experiencing it (Gardner, 1988; Tulving, 1985). But how should this reintroduction of experience impact upon the scientific study of animals and young children? This is the question we shall tackle in our paper, by examining the implications for a new form of minimalism about episodic memory for comparative and developmental psychology. First, we need to explain what is intended by the term minimalism.

The original definition of episodic memory offered by Tulving is an example of conceptual minimalism, in our terms. For, to say that “Episodic memory stores and retrieves information about temporarily-dated episodes or events, and temporal–spatial relations among events (Tulving, 1972, p. 385) and that “To ask a person about some item in episodic memory means to ask him when did event *E* happen, or what events happened at time *T*” (Tulving, 1972, p. 388) would seem to be to omit a lot of what is seemingly

essential to human episodic memory in terms of subjective experience and of conceptual abilities. Of course, over the years Tulving (1983, 1985, 2000, 2002, 2005) has added layers to this minimalism until it contains all one could desire in terms of phenomenal and conceptual richness: “[Episodic memory] is probably unique to humans. It makes possible mental time-travel through subjective time—past, present and future. This mental time travel allows the “owner” of the episodic memory (“self”), through the medium of auto-noetic awareness, to remember one’s own previous “thought about” experiences. . .” (Tulving, 2005, p. 15).

Meanwhile, over in developmental psychology, Josef Perner has stressed both the necessary contribution to episodic memory of the theory-like ability to appreciate how past perceptual experiences can cause current knowledge (Perner, 2001) and the role of introspective abilities that are similarly theory-like (Perner, Kloo, & Stöttinger, 2007). This too is a far cry from the minimalism of the early 1970s.

What, then, is the empirical cash-value of the early minimalism espoused by Tulving and later denied by theorists such as Tulving and Perner? It is that if an organism, not necessarily a human adult, can recall *what* happened *where*, and *when* (a WWW memory) then it has achieved episodic recall. According to one of us, this implication follows from the kind of 1972 definitions quoted here (Clayton & Dickinson, 1999); and the legitimacy of this reading has never been challenged by Tulving. Indeed he has acknowledged that “Nicola Clayton’s scrub-jays would have been certified as

* Corresponding author.

E-mail address: nsc22@cam.ac.uk (N.S. Clayton).

full-fledged episodic creatures back in 1972” (Tulving, 2005, p. 47). It goes without saying, that this view of episodic memory does *not* invite the phrase ‘is probably unique to humans’.

Given this background, it is not surprising that there is currently an impasse between those who argue that the existence of WWW memories in animals (in Western Scrub-Jays in particular) means that they possess episodic memories, and those who believe that we should take episodic memory to mean just what Tulving’s later elaborations of it mean (principal members of the latter camp are Suddendorf and Corballis, and Tulving and his collaborators; e.g. Suddendorf & Corballis, 1997, 2007; Tulving, 2002, 2005). Meanwhile, enthusiasts for the minimalist definition can reply that there is no reason why one may not prefer a psychologist’s earlier phase of theorising to later ones, and that indeed we have witnessed this in Hulme and Mackenzie (1992) on Baddeley’s model of working memory and Pinker and Jackendoff (2005) on Chomsky’s theory of syntax.

But the sceptic will reply, in turn, that it is not just a question of early versus late-phase theorising, because there is a very good reason why Tulving made the theoretical elaborations he made, namely, in order to capture these additional features of human episodic memory. It is one thing to use the empirical framework afforded by the 1972 definition to collect evidence for ‘episodic-like’ memory (Clayton & Dickinson, 1998; Clayton, Bussey, & Dickinson, 2003) but quite another to refer to the jays’ performance in terms of ‘mental time travel’.

We feel, however, that the enthusiast’s reply is a strong, if not unanswerable, one. Episodic memory involves an organism re-experiencing an earlier situation. Given this, it stands to reason that *just as human episodic memory will inherit what is present in human experience, so will avian episodic memory inherit the character of avian experience*. It is a datum that human experience takes place within a background of self-awareness and networks of conceptual abilities, while it is our best bet that avian experience does not do so, or at least does so to a lesser extent. Therefore, we should adopt a minimalist *non-conceptual* account to study avian episodic memory.

In itself, however, this answer will not allow an escape from the impasse, mainly because it is so easy to describe WWW memories in semantic terms, that is, in terms of the animal just *knowing* what was hidden where and when as opposed to re-experiencing the caching event. But we believe the case for a minimalist account of episodic memory has been made, if we are serious about the very possibility of its existing in animals. Our aim, then, is to introduce a new form of minimalism. In later sections we shall describe this and then show how it can be applied to some current developmental data. All we will say about it for now is this: Our form of minimalism claims as a necessary component of episodic memory in all creatures, and perhaps as a sufficient condition for episodic memory in animals, that the organism re-experiences a perceptual relation between itself and data of some kind. We call this a “perspective”; and hence use the term *perspectivism*. This relation is most naturally understood in the case of spatial coding, but it also exists in terms of temporal relations and can also be easily appreciated with respect to modal relations.

We shall elaborate this claim in Section 2. In fact, the following issues will be covered in this paper.

1. A review of the evidence for episodic memory in animals, with particular attention to the WWW experiments.
2. Minimalism explained. We discuss the meaning of “non-conceptual content” in relation to episodic memory, and set out the perspectivism thesis, describing its roots in Kantian theory.
3. The implications of the perspectivism thesis for the development of episodic memory are followed through. The discussion of how

episodic cognition can be assessed in children will illustrate the empirical cash-value of the thesis, because in some developmental tasks perspectivism has been assessed and in others it has not.

4. We take stock and also sketch some novel tasks that could be given to children and animals in order to directly assay the perspectival nature of their memory traces.

1. Episodic memory in animals

As discussed earlier, Clayton and Dickinson (1998), following Tulving’s (1972) early minimalist definition of episodic memory, considered cases in nature in which an animal will benefit from the capacity to remember a specific past episode of what happened where and when. One example concerns members of the crow family, which like other food-caching animals, hide or cache food, and rely on memory to recover these food caches at a later date (see Clayton, Griffiths, Emery, & Dickinson, 2001 for other examples of potential candidates of episodic-like memory in nature). Given that these birds rely on their caches for survival in the wild, it seems likely that the selection pressure for remembering which caches were hidden where and how long ago would have been particularly strong (Griffiths, Dickinson, & Clayton, 1999), particularly since they cache year round (Curry, Peterson, & Langen, 2002). These birds also cache reliably in the laboratory, providing both ethological validity and experimental control (Clayton, 1999).

Clayton and colleagues focused on the behavioral criteria for episodic-like memory, namely that the animal must be capable of remembering what happened where and when on the basis of a single past experience, and in a way that cannot be explained in terms of relative familiarity. To do so they focused on one particular species of crow, the western scrub-jay. In order to test whether these food-caching jays could remember the what where and when of specific caching events, Clayton & Dickinson (1998) capitalized on one feature of the scrub-jays’ ecology, namely the fact that these birds cache perishable food items such as worms and other invertebrate prey as well as non-degradable nuts and seeds, and as they do not eat rotten items, recovering perishable food is only valuable as long as the food is still fresh. Consequently, the jays might need to remember not only where they have cached, but also which foods are perishable and how long ago they hid them. At this point it is also worth noting that not all food-caching animals hide perishable items. Grey squirrels, for example, avoid the problem of perishability that the jays have by removing the cotyledon from acorns before they cache them, and this prevents the nuts from germinating and thus spoiling as a food source (Steele, Turner, Smallwood, Wolff, & Radillo, 2001).

In order to test whether these birds remember the what where and when of specific caching episodes, the jays were given a series of trials in which they could cache their preferred food ‘wax worms’ and the less preferred peanuts in two sand-filled ice cube trays, both of which were made visuo-spatially distinct and trial-unique by attaching Lego Duplo® blocks to the sides of the trays (Clayton & Dickinson, 1998). The birds were given the opportunity to cache in different pairs of trays on different trials so that each caching episode was unique. Although the birds had no cue predicting whether or not the wax worms had perished other than the passage of time that had elapsed between the time of caching and the time at which the birds could recover the caches they had hidden previously, the birds rapidly learned that wax worms were fresh when recovered 4 h after caching, whereas after 124 h, the worms had decayed. Consequently, the birds avoided the worm caches and instead recovered exclusively peanuts. It was because the animals had been hand-raised, and we therefore knew their precise reinforcement histories, that we could be certain that they had no prior experience of degrading worms.

Having received four pairs of training trials, the birds received a pair of test trials, in which the caches were removed prior to recovery and the trays were filled with fresh sand in order to ensure that the jays could not use any cues emanating directly from the hidden food in order to choose where to search. The jays searched primarily in the places in which they had hidden the wax worms when the food had been cached 4 h ago, but the birds switched to searching in the peanut sites when the food had been cached 124 h ago, suggesting that they did remember what they had hidden in which particular trays and how long ago. Note that the recoveries after both short and long retention intervals always occurred at the same time of day (4 h after caching on the same day as caching or 5 days after caching) and therefore neither circadian rhythms nor the state of hunger at the time of recovery could provide cues to guide the jays' searching behaviour (see de Kort, Dickinson, & Clayton, 2005 for further discussion).

The critical issue, however, is whether the birds remembered the specific past caching episodes or whether they simply knew what had been cached where and when based on their familiarity with the caching trays. The point is that it is possible that rather than remembering how long ago they had cached the worms and nuts in the particular cache locations, the jays had relied on familiarity judgments with the caching trays in order to decide whether or not to search for the worms as opposed to the peanuts. When caching had occurred just 4 h previously the trays are presumably much more familiar than when caching occurred 124 h ago, and so the jays might have used a conditional rule 'if the trays look familiar search for worms, but if the trays look relatively unfamiliar search for peanuts'.

To discriminate between recall and familiarity, Clayton and Dickinson (1999) gave the jays a further test trial in which the food caches had been removed prior to recovery and the trays were filled with clean sand to remove any olfactory cues in order to test for memory. To do so they used an interleaved trial procedure in which the jays were allowed to cache one food type on one side of a tray while the other side of the tray was made inaccessible for caching by attaching a transparent plexiglass strip to cover all the caches sites on that side of the tray. The birds then received their trays again on the morning of the fifth day so that they could cache the second food type in the previously inaccessible side of the same tray, and they were prevented from recovering the previous caches because the plexiglass strip had now been attached to the other side of the caching tray. In the afternoon of this day 5, the jays were allowed to search in both sides of the tray. What is important here is that the interleaved procedure removes the differential relative familiarity of the tray because the temporal pattern of exposures to the tray were the same irrespective of whether or not the worms had been cached first, 124 h ago, or second, just 4 h ago. As the caches were not present at recovery, the birds had to rely on their memory of the previous caching episodes in order to search for the appropriate food, namely worms if they should still be fresh and nuts if the worms should have perished.

Consistent with the episodic recall account, the jays spontaneously searched for the worms they had cached 4 h earlier, whereas when they had cached the worms 5 days ago then they ignored searching in the worm sites and instead searched for peanuts. This pattern of recovery suggests that the birds were not using tray familiarity as a cue but rather that they were remembering specific past caching episodes in terms of where they had hidden the peanuts and worms, and how long ago. Subsequent work established that the jays could also keep track of two perishable foods that decayed at different rates (Clayton, Yu, & Dickinson, 2001).

Critics have argued that as the jays had received a number of training trials in which they could cache and recover the vari-

ous food items, these birds may have learned to solve the task by acquiring semantic knowledge about when to recover the particular foods rather than recalling episodically which foods had been cached where and when (e.g. Dere, Huston, & De Souza Silva, 2005; Hampton, Hampstead, & Murray, 2005; Zentall, Clement, Bhat, & Allen, 2001). These claims misunderstand the theoretical interpretations of the role of semantic and episodic-like memory in the control of caching, namely that the birds use their 'semantic-like knowledge' of the rate at which worms decay but in order to decide where to search they need to integrate this information with their episodic-like memory of a particular caching event in which they hid the foods in specific locations in those particular trays. As Clayton and colleagues have argued, in order to choose to search in a particular tray for the perishable caches only when fresh and not when degraded the birds must integrate a semantic-like rule about how long each food type remains fresh with a specific episodic-like memory of which caches they had hidden where in a given tray on a specific day because each caching event is indeed unique (Clayton, Yu, & Dickinson, 2003).

1.1. *Alternative animal models of episodic-like memory*

Other researchers have also begun to establish models of episodic-like memory in non-human animals other than western scrub-jays (reviewed by Salwiczek, Dickinson, & Clayton, 2008). For example, Hampton and colleagues (Hampton et al., 2005) adapted the scrub-jay food-caching paradigm to test whether rhesus monkeys could remember the what, where and when of specific foraging events by allowing the monkeys to explore a room that contained three foraging sites, two of which were baited and one was unbaited. The monkeys had to learn that all the food was fresh after 1 h, but their preferred food was rotten and therefore inedible after 25 h even though the less preferred food remained fresh. Although the monkeys rapidly learned to search first for their preferred food, and to avoid the empty foraging location, they were unable to reverse their search patterns after the long delay but instead they re-visited those locations that contained their preferred food irrespective of the length of the delay. In short, the monkeys remembered the 'what-and-where' of trial-unique events but, unlike the jays, they failed to remember 'when'. Salwiczek et al. (2008) argue that the foraging paradigm might be less suitable for testing episodic-like memory in rhesus monkeys given that they do not naturally cache perishable and non-perishable foods and certainly their survival does not depend on them burying food for later. Furthermore, their feeding ecology does not require them to keep track of decay rates as they are primarily herbivorous (Hampton et al., 2005).

Rats are known to hoard food, but when Roberts and colleagues tested laboratory rats for their ability to remember which foods had been cached where and how long ago they also found no evidence that their rats could remember when they had cached various food types (Bird, Roberts, Abroms, Kit, & Crupi, 2003; McKenzie, Bird & Roberts, 2005). However, most species of rat do not cache the vast quantities of food in the wild that jays and other food-caching corvids do (Vander Wall, 1990) and, like primates, but unlike the jays, the rats do not rely on their caches for survival (Vander Wall, 1990). When viewed in this light perhaps it is not so surprising that the rats behaved like the monkeys rather than like the jays. That is to say that at recovery, the rats preferentially searched in those locations in which they had hidden food more often than other locations that had not been associated with food yet there was no evidence that they encoded the when because they did so even when items repeatedly degraded or were pilfered before recovery (Bird et al., 2003, McKenzie et al., 2005).

That said, recent work by [Babb and Crystal \(2005\)](#) has provided some evidence that rats remember the what–where-and-when of specific past events. Instead of hoarding the food items themselves, the rats were trained in an 8-arm radial maze in which they had to remember where they had previously encountered food that they could subsequently recover after either 1 h (the short RI) or after 25 h (the long RI). During the first phase the rats were allowed to search for food located at the ends of 4 arms of the maze (the other 4 arms were blocked): 3 of them with regular pellets and 1 with highly preferred chocolate pellets. The rats were subsequently returned to the maze during a second phase in which all 8 arms accessible, the 4 previously inaccessible arms being baited with regular pellets. In addition the chocolate pellets were replenished if the rats were returned to the maze after a long delay, but not after a short RI. Babb and Crystal argued that if the rats could remember which arms they had visited in phase 1, then in phase 2 they should selectively search in the previously inaccessible arms, because those were the ones that would still contain food. If they could also remember which foods were available where and how long ago they had visited them in phase 1 then in phase 2 they should prefer to visit the arm containing the chocolate pellets after the long RI, but avoid that arm after the short RI. Babb and Crystal found that the rats did learn to avoid the previously baited arms and to re-visit the chocolate arm after a long RI only, demonstrating that rats could use the length of the retention interval as a cue to guide their choice of where to search, a finding that has also been replicated by Roberts' group ([Naqshbandi, Feeney, McKenzie, & Roberts, 2006](#)).

Taken together, the results of these studies on other non-human animals suggest that it is the 'when' component that is the most challenging feature. In some of the studies, the animals do not show any sensitivity to the when component of past events, remembering what was hidden where but not when ([Bird et al., 2003](#); [Hampton et al., 2005](#)), and whilst absence of evidence is not evidence of absence, the fact that rats do appear to remember what happened where and how long ago when tested for the memory of food they have seen previously ([Babb & Crystal, 2005, 2006a, 2006b](#); [Naqshbandi et al., 2006](#)), but not food they have cached previously ([Bird et al., 2003](#)) might be taken to suggest that the ecological validity of the task may be critical. One advantage of the food-caching paradigm that was developed for the western scrub-jays is that it taps into their natural propensity to cache and recover perishable food when fresh and to avoid those items that have degraded and are therefore no longer palatable. Perhaps then it is not surprising that magpies, a relative of the scrub-jay (i.e. a fellow member of the crow family), can also remember which foods they have cached where and how long ago ([Zinkivskay, Nazir, & Smulders, in press](#)).

Two outstanding issues in the rodent memory models is whether the animals may have solved these tasks using relative familiarity or rule learning as a result of intensive training rather than by episodic recall ([Babb & Crystal, 2005, 2006a, 2006b](#); [Schwartz & Evans, 2001](#)), and the extent to which an animals' ability to remember and discriminate between sequences (e.g. [Agster, Fortin, & Eichenbaum, 2002](#); [Ergorul & Eichenbaum, 2004](#); [Fortin, Wright, & Eichenbaum, 2004](#); [Schwartz & Evans, 2001](#)) depends on episodic-like recall. This is particularly pertinent given the very recent finding by Bill Roberts and his colleagues ([Roberts et al., 2008](#)) that rats could remember the when of an episodic-like memory trace in terms of the relative time elapsed (how long ago) but not in terms of an absolute time of day at which the event occurred, leading the authors to conclude that episodic-like memory in rats is distinctly different from human episodic memory traces.

Other researchers have challenged whether the encoding of the 'when' component is central to the concept of episodic-like mem-

ory or whether in fact it is the context in which the event occurred that is critical (e.g. [Dere et al., 2005](#); [Eacott & Norman, 2004](#); [Kart-Teke, De Souza Silva, Huston, & Dere, 2006](#); [Norman & Eacott, 2005](#)). For example, remembering two meals with the same friend are discriminated in memory by binding each episode to the different contexts provided by the two restaurants. Eacott and colleagues exploited this concept of episodic memory by capitalizing on the rat's propensity to seek out novelty. Their rats explored two different objects placed in a certain spatial configuration in a particular context, before investigating them again in a different configuration in a second context. Following this episode, the rats were exposed to one of the objects in a different place until they were bored with it, an experience that enhanced their propensity to seek out the other object when returned to the original contexts. The rats could only do this, however, if they could remember where the objects were located in a particular context during the initial episode. Eacott and colleagues argued that the rats recollected the object (what) and its location (where) in a particular context (which) on the basis of unique "what-where-which" memories ([Norman & Eacott, 2005](#)).

1.2. Flexibility is a crucial characteristic

The case in scrub-jays is certainly more extensive, perhaps because it capitalizes on the animal's natural propensity to cache, a behaviour these birds 'do for a living' and perhaps because these were the earliest studies to assess episodic-like memory by controlling for relative familiarity. Clayton and colleagues have argued that this representation of the time since caching is essential for the efficient recovery of perishable food items and that western scrub jays use a flexible, declarative memory system to do so ([Clayton, Yu, et al., 2001](#); [Clayton, Yu, et al., 2003](#)). For example, the jays were not only capable of keeping track of foods that perish at different rates but could also discriminate between episodes in which they had cached the same type of food but in different places and at different times, and thus on test trials in which no food was actually present at recovery, they searched in those sites in which the worms should still be fresh as opposed to those sites in which the worms would have degraded ([Clayton, Yu, et al., 2001](#)). Furthermore, when jays received training trials in which the preferred food was found to improve with age rather than deteriorate, the jays switched to searching for the preferred food after the long delay ([de Kort et al., 2005](#)), suggesting that the birds were not simply forgetting whether they had cached the preferred food after long time intervals.

Perhaps the most impressive demonstration of flexibility comes from a study in which the jays were allowed to cache perishable and non-perishable items, but then discovered in the interval between caching and recovery that the perishable food type degrades more quickly than originally thought ([Clayton, Yu, et al., 2003](#)). This experiment was also informed by considering the animal's natural caching behaviour, in this case an ecological factor concerning the 'perishability problem' that the jays face, namely that environmental factors will influence how quickly a particular item degrades. For example, an item cached in the shade will take longer to rot than one cached in an area that is exposed to the direct sun light, and the caches are more likely to spoil more quickly if there are a spate of sunny days than if there is a cold spell immediately after caching. Indeed, the jays cache perishable foods in an environment where the rate at which foods decay changes across the year, and from day to day, depending on the weather conditions between caching and recovery. So fast in fact, that flexible learning may be essential to their survival. For jays that live in the Central Valley (California, USA), the ambient temperatures rarely fall below 10 °C but may rise to over 40 °C between July and

September. At such temperatures, caches that consist of various invertebrates, for example, will degrade rapidly in the heat and more slowly in the cold. So the problem for a scrub-jay is not only to learn how quickly a particular food type degrades, but also to be capable of updating information in a flexible manner, based on the ecological conditions that occur in the interim between caching the item and recovering it (de Kort et al., 2005).

Consequently, Clayton and colleagues reasoned that if the birds do use a flexible declarative memory system then they should be able to update their knowledge about the rate of perishability of the food and change their search behaviour at recovery accordingly, even though the episodic information about what they cached where and when was encoded prior to the acquisition of the new knowledge about the decay rates. The jays were able to do just that—if they cached perishable and non-perishable items in different locations in one tray and then subsequently discovered that the perishable items from another tray had degraded more quickly than they expected, then when given the original tray back the birds switched their search preference in favour of the nuts. The birds continued to search for the perishable food if it had been cached recently, thus showing that they had not simply developed a general aversion to searching for food that might perish. To our knowledge, this is the only published demonstration of the declarative flexibility with which animals can update their information after the time of encoding (Clayton, Yu, et al., 2003).

Further evidence for the sophistication of their episodic-like memories comes from studies of the social context of caching (reviewed by Clayton, Dally, & Emery, 2007). These birds readily steal one another's caches and go to great lengths to protect their own caches from being stolen by another bird, hiding them behind barriers (e.g. Dally, Emery, & Clayton, 2005), and re-caching those caches another individual has seen them make once that other individual has left the scene (Emery & Clayton, 2001). These jays recognize particular individuals and remember which particular individual was watching them cache during specific past caching episodes and take protective action accordingly (Dally, Emery, & Clayton, 2006). It is this integrated structure of their episodic-like memories that allows them to discriminate between caching episodes that differed only in terms of who was watching when, just as in the case of discriminating between caching episodes that differed only in terms of when the different worms were cached where. Perhaps the most striking facet of the jays' behaviour, however, is that only those birds who have themselves been thieves in the past re-cache the food others have seen them make and only if another bird witnessed the caching event. The fact that naïve birds who have not been thieves do not do so led Emery and Clayton (2001) to argue that 'it takes a thief to know one'.

This finding has a number of important implications. The first is that this behaviour cannot be innate, otherwise all the birds should re-cache. We can also rule out a simple conditioning explanation because the birds never received any positive reinforcement or any punishment for re-caching, given that they never had the opportunity to learn about the fate of the caches that they had re-cached. Emery and Clayton (2001) therefore suggested that the jays use information gained during the previous caching event to anticipate whether or not its caches were likely to be stolen, and thus engaged in the appropriate cache protection strategy at recovery, namely whether or not to re-cache. Indeed Emery and Clayton (2004) have argued that the fact that experienced birds differ so dramatically from control birds who lack the experience of being a thief suggests that the experienced jays are not only capable of protective action against future theft, but also experience projection. Taken together these findings provide striking evidence for the flexibility of these birds' episodic-like memories.

1.3. The lingering interpretive issue

We have seen then that the adoption of the WWW criterion, or something like it, has paid enormous dividends in the study of animals' episodic memory Clayton, Emery, & Dickinson, 2006. But what do we say to critics such as Suddendorf and Corballis (2007), who insist that the birds could have completed the tasks by 'semantic' processes. After all, any memorial behaviour that can be explained in terms of an agent's re-experiencing an episode can also be explained in terms of its carrying out a sequence of semantic computations without any accompanying phenomenology. It is perfectly possible to acquire 'what, where and when' knowledge without having to re-experience those events, some insist. This is the essence of the impasse described earlier.

We suspect, however, that much of the motivation for insisting on a semantic reading of the animals' success emanates from the difficult-to-abandon belief that birds and rats (at least) simply lack the conceptual apparatus to engage in episodic memory. This is certainly an easy belief to adopt if one defines episodic memory much as Tulving (2005) does in his later work. What we shall do in the next section is to introduce a new form of minimalism, in which episodic memory is described in non-conceptual terms. This is not supposed to establish that indeed any creature who can pass a WWW task is thereby demonstrated as using episodic memory. In fact we stress the role of *mental perspectives* rather than this triad. However, we do hope to achieve two things: (1) *blocking any blanket dismissal of the possibility of episodic memory in animals on the basis of their possible conceptual shortcomings*; and (2) *opening new empirical avenues for the study of episodic memory in animals and young children*.

2. Perspectivism in episodic cognition

Episodic memory involves re-experiencing situations. As a first step towards saying what is essential to re-experiencing, as compared to performing semantic computations about past events, we make the following central claim: *the process of re-experiencing will inherit what is essential to adequate objective experience itself*. Thus, if objective experience (i.e., 'objective' as any experience that takes an object—inner experiences, like pains, as well as outer ones like buses) must have character X for it to be adequate then re-experiencing (or episodic memory) must also have X. For an analysis of what is indeed essential to objective experience (or 'how objective experience is possible' Cassam, 2007) one turns naturally to Kant's discussions in the Transcendental Aesthetic section of the *Critique of Pure Reason* (Kant, 1781/1998). This is a sustained and radical, though relatively short, piece of a priori psychology.

Kant argued – we closely follow here the exposition of Guyer (2004) – that for the experience of objects (inner or outer) to be possible at all this experience must be grounded in space and time as pure 'forms on intuition': these two must precede and structure all experiences of outer and inner states. We cannot derive a conception of space and time from the experience of objects because this experience presupposes the individuation of objects in space and/or time. What needs to be stressed right away is the fact that the kind of space that is being referred to here is not absolute space but egocentric space, in which spatial relations between viewer and objects are coded. (As we shall be discussing later, we do not intend 'egocentric' space to mean spatial coding in terms of locating entities in terms of a spatial framework *fixed to body parts*, but as meaning a framework in which the *relation* between the observer-agent and objects at locations is being coded—as compared to a wholly environment-centred coding. Perhaps the term 'viewer-relative' would be better. Kant himself wrote about

the 'orientable' nature of special knowledge: *mit Orientierung*, see Hanna, 2008, for discussion.)

Kant was writing about the *experience of objects as they appear to us*, not the objects of physics, or properties of, or relations between, things as they are in themselves, and certainly not real entities such as Newtonian space. As Kant put it elsewhere (Kant, 1992/1770 p. 366), "Considering the things which exist outside ourselves: it is only in so far as they stand in relation to ourselves that we have any cognition of them by means of our senses at all. It is not therefore surprising that the ultimate ground on the basis of which we form our concept of directions in space derives from of the relation of these intersecting planes [the three dimensions] to our bodies."

A little later in this section we shall dig deeper into this claim with regard to space in particular and in order to spell out the way in which these conditions are 'non-conceptual', but for now we will examine the following implication of this claim for episodic memory, in order to keep the ultimate goal clearly in view. *If experience has a spatial content and if episodic memory is re-experiencing then episodic traces must have spatial content.* This claim is open to introspective test (given that experience is our topic) against human episodic memory. We are not of course claiming that human episodic memory is a non-conceptual process! The claim is that for there to be episodic memory in any creature, what makes it an *experience* is something non-conceptual. When we have done this, the term 'non-conceptual' will be thoroughly explicated.

We can do this introspective job by looking at the kind of judgments one would be inclined to make in response to people's memorial claims. If, for example, Jake says that he can remember seeing a goal being scored at a soccer match he attended last week while being adamant that he has no memory of where he was sitting in relation to the goal-scoring (behind the net, on its left or right) and that he has no memory of whether he was sitting at the back of the stadium or right down the front, then we would be inclined to say that this report was not truly a case of re-experiencing. Similarly, if he says he recalls being interviewed for a job but has no idea where the various interviewers were sitting in relation to him, or cannot recall whether he sat at the head of the long rectangular interview table or whether he sat before its side with the panel ranged behind the other side then we would be inclined to say that Jake was not re-experiencing the event. We do not of course claim that the accuracy must be perfect in these cases, but it must be at least partial.¹

This kind of case, in which the structure of the interacting objects is fairly rich, constitutes a quite straightforward case of viewer-relative spatial content. But there are many easy-to-generate problem cases, some of which will recall developmental experiments. Accordingly, when a subject is shown a ball being put into a box A rather than box B as contrasted with the case when she is told which box contains the ball, the spatial relation between the individual and the objects is not a defining feature. If you are shown something directly then necessarily it is in front of you; if you are told something by somebody directly then necessarily you will be within earshot. A more problematic case still is one in which a subject simply looks directly at an object, with the question being whether she has an episodic memory of the encounter: Does she 'remember' (episodic) or 'know' (semantic) that it showed a picture of a pig in a field? (Tulving, 1985). In so seeing, what other relation can there be but 'in front of viewer'?

In reply, it can be said first that spatial content does indeed have a foothold in the ball-in-box cases. If the subject really has no idea whether she saw the hiding from above or from the side, from close-up or from a distance then it would seem she is not recollecting an experience. Also, in the hearing case, if there was no recollection of whether the telling was direct or by telephone then we would be inclined to say no episode was being re-experienced. With regard to the picture of the pig example, there was indeed a spatial relation involved, albeit the default one of the right way up, something less than arm's length and more than spectacle's distance, and with the picture somewhere between the top of the head and the knees. Given this, if it was really a case of remembering rather than knowing then one would reasonably expect any deviations from this default to be recalled—an extreme tilt (and of course an inversion), a distance so great that the pig could be barely made out.

2.1. *Non-conceptual content and the spatial content of experience*

A minimalist conception of episodic memory depends upon the idea that it is not the possession of certain concepts or conceptual abilities (e.g., self-in-past, past-experience-causing current knowledge, mental time-travel) that marks the difference between episodic memory and other kinds of memory: the 'experience' in 're-experiencing' is made possible by something non-conceptual. The first things to say here are that philosophers are divided over the very existence of non-conceptual mental content, and those who argue for its existence do not agree on a definition of it. In any event, we will use the following definition taken from a paper by Hanna (2008, p. 42), on which we shall be reliant, not least for the author's reading of Kant:

"The thesis of *Non-Conceptualism* about mental content says that representational content is neither solely nor wholly determined by our conceptual capacities, and that at least some contents are both wholly and solely determined by non-conceptual capacities and can be shared by human and non-human animals alike".

Notable philosophers who take this view are Evans (1982, chaps 4–6), Peacocke (2001), and Bermúdez (2003). Ranged against them are those who espouse *Conceptualism* about mental content, which says that content is entirely determined by the conceptual capacities the individual has. Conceptualists claim that when an organism has an experience the representational content of that experience is always conceptual (see Peacocke, p. 244 et seq). Given this view, conceptualists will tend to hold that animals do not have mental content (e.g., Brewer, 1999; McDowell, 1994). The lemma lurking in all this is that concepts require language. We side with Bermúdez (2003), in fact, in rejecting this view. As applied to the Clayton and Dickson WWW studies, there is no reason to deny that the concept of, say, wax-worm is involved in the putative episodic memory, but we do deny that the exercise of concepts of any kind makes it a case of re-experiencing.²

Now while Kant is properly regarded as the main provider of considerations in favour of conceptualism, not least in his doctrine of the twelve 'categories' that structure all objective judgement, he can also be regarded as the philosopher who argued for non-conceptual experience as something that must be combined with conceptual abilities in all judgment and that can exist without them. He wrote, for example, "He who sees his first tree does not

¹ We accept that what we say is not obviously true of auditory episodic memory. For example, introspection is unlikely to answer questions very clearly about the phenomenology of recollected News items and musical performances. It is an empirically determinable matter however.

² One might say here, in fact, that the What in WWW is conceptual but the Where and the When are non-conceptual. This is inkeeping with the Kantian position we are developing.

know what it is that he sees” (quoted in Hanna, 2008, p. 45). Not only this, but he fielded an argument for the existence of spatial, non-conceptual content, which has become known as the ‘two hands argument’ or THA (Kant, 1992/1770, p. 370; discussed in Hanna, 2008, pp. 53–57).

Here is one way of describing the lesson of the THA. What do the different ways in which we experience the spatial positions of our left and my right hands amount to? Is it something conceptual? Can it be captured in terms of the fact that we write with one hand and wear a ring on the other and that one of them is on the same side as my hair-parting? THA makes the point that it need not be conceptual at all. If you place a mirror beside your right hand with the glass facing it, what you see in the mirror an equal distance behind the glass is a left hand—not *the* left, but your right hand on your left: it is ‘on my left’ in the spatial way that my left hand is. But this mirror-image hand has an odd status in that while it is qualitatively, and thus *conceptually*, identical to my right hand it is topologically non-identical. That is to say, not only are the hands in different places within my field of experience but no possible transformation of the right hand could yield the mirror-image/left one. (Note that we have to have differently-shaped gloves for the left and right hand despite their being mirror-images.) In the jargon of topology, they are *enantiomorphs*. There is then no conceptual difference at all between one hand and its so-called ‘incongruent counterpart’ (Kant’s term). This implies that there is no form of words that could convey to somebody who had never directly confronted the two objects of experience in this way what the difference consists in. It is entirely one in terms of different spatial orientations to one object in two places (or two objects in two places in the case of real hands). The difference is entirely non-conceptual in both cases and unarguably so in the mirror case.

The moral of the story is that “only non-conceptual content can adequately represent the unique location of material objects and of embodied subjects’ own unique spatial and temporal standpoint” (Hanna, 2008, p. 58). Kant developed in the *Transcendental Aesthetic* the idea that space and time are a priori subjective forms of sensibility (*Sinnlichkeit*). However, as Hanna reminds us *Sinnlichkeit* was supposed to include not only sense perception but also the ‘inner sense’—imagination, pleasure, pain, desire. In fact, “we should think of the representation of space and the representation of time as the necessary a priori subjective forms of egocentrically centred human and non-human animal embodiment” (Hanna, 2008, p. 58). Building on this, we claim that memorial re-experiencing is a form of inner sense, akin to the imagination. This is to say, that whatever it is that gives episodic memory its phenomenology is non-conceptual and, given this, that animals need not have limited episodic experience in virtue of their limited conceptual apparatus; though their re-experiencing will inherit the conceptual character of their experiencing. It would be unwise to deny the possibility that different kinds of animal can differ in terms of their ability to engage their episodic capacities *at will* and that conceptual abilities may have a role to play here, but what makes re-experiencing an *experience* is not essentially something conceptual.

2.2. Looking more closely at ‘perspective’

The perspectival element here is, we argue, more fundamental than the spatial, as the spatial is ‘only’ one way in which a subject can enjoy a sensory relation to a datum. Accordingly, in this section we will flesh out a little what can be said about temporal relations and also go well beyond Kant to discuss modal (qua sensory-modal) relations.

Time first. For Kant, time, like space, is a form of sensibility, or what one might call a psychological condition for there being any

experience at all, rather than self-subsistent (Newton) or a system of relations among objects (Leibniz). The temporal content Kant had in mind was not the dated nature of the experience, nor the way in which an experience fits into the broad temporal order of life events, but the bare fact that there will necessarily be ‘co-existence’ (simultaneity) and ‘succession’ (temporal order) in an experience, even one of minimal complexity. Now there is no clear sense in which the experience of temporal order (we include simultaneity within this term for now) is perspectival, but it does inherit a perspectival character insofar as it must be *bound* to spatial content if an episode is to be recalled veridically. For example, if we experience an action on our left and then one on our right, or if we experience two objects simultaneously present on our left and our right, then we are necessarily binding location to temporal order. So when it comes to recollecting this episode we have to bind, in memory, the nature of the order to the locations, and of course to the nature of the object or event (to the ‘What’—see footnote 2). In this sense, then, temporal order partakes of the spatial–perspectival quality of episodic memory.

We now dig a little deeper into the role of temporal order and do so with the help of a later section of the *Critique*, namely, the famous Second Analogy section. We shall engage with a distinction drawn there, though not with the significance that Kant attached to it (Russell, 1996, 1999, on its significance for developmental psychology). To put it in an un-Kantian way, an organism can be related to a temporal sequence either as an observer or as an agent. In the first case, it will perceive A, then B, then C; and the world imposes this particular order on it. In the second case (e.g., when scanning a complex object like a room) the organism can determine the order for itself (ceiling, then floor. . .) and indeed reverse the order at will. The conjecture we derive from this is that if the organism is re-experiencing a particular engagement with reality then it should be able to recall whether this engagement was perceptually ‘passive’ or ‘active’. There could be empirical tests of this. Indeed the research by Marcia Johnson and others (Johnson, Kounious, & Reeder, 1994) into ‘reality monitoring’, in which subjects must distinguish world-generated from self-generated (imagined) stimuli in memory is within this domain. Indeed it also falls under the general heading of source monitoring (Johnson, Hashtroudi, Lindsay, 1993), which is out next topic.

We shall say no more about time but turn immediately to a relation that is familiar to psychologists as source memory. Just as the organism can be related to a set of ordered percepts as observer or agent so, we suggest, it can be related to a datum as see-er, or hearer, or toucher or smeller—via different sensory modalities. But is the parallel between spatial (self ← objects) and sensory (self ← a modality ← informational source) in danger of becoming fatally over-stretched? We would defend the notion of a modal relation in the following terms. In the spatial case, the relation is *one:many* (one experiential point to many objects³) and in the modal case it is *many:one* (a finite number of modal experiential points and one source of information. For some, the term ‘source of information’ may seem too vague for comfort; but all that is being intended here is (a) the array of objects in the visual and tactile cases, (b) the source of the broadcast sound in the auditory case, and (c) the source of the smell in the olfactory case. In any event, if the notion of a modal perspective can be sustained in the way we intend, then it follows that source memory is episodic memory. It is recalling *as what kind of experienter* one was related to a datum; and if it really was an experience (as compared with have being told whether one saw or

³ We say ‘many’ because in the case of a single object like a card with a picture, there can be parsing into more than one object—such as the card and the item pictured on it.

was told something) then this memory will have spatial content too, and one will also recall – though are proposals are more tentative here – whether one was an active or passive perceiver in the episode.

2.3. A definition defended

We are now in a position to propose and briefly defend a definition of a perspectival memory trace, with this being our minimalist conception of episodic memory.

A memory trace is perspectival if it instantiates a spatial relation (bound to temporal-order) and/or a modal relation between an organism and an earlier situation.

Objection 1

In the definition, the relation referred to is between the organism *in the past* and a situation in the past so there is no escaping mental time travel.

Answer

This pastness consists of background semantic knowledge/context not phenomenal experience, which comes from perspectivism. The organism must know that the trace is informative about the past and may even know when in the past the situation occurred, but this need not imply that it conceptualises itself as revisiting a point in the autobiographical past, while still being in the present, in order to glean this information. The perspectival trace is simply dated, vaguely or precisely. Mental time travel does not provide the phenomenal content.

Objection 2

At least with regard to space, the perspectivism view falls foul of the neuroscience of episodic memory, in the following respects. It is widely accepted that the hippocampus is crucially implicated in episodic memory. However, at least one highly influential model of the function of the hippocampus in spatial processing (O'Keefe & Nadel, 1978) has it that the kind of spatial representation computed in the hippocampus is allocentric, absolute and objective, *not* perspectival. On this model, the animal is said to compute a representation of the environment that is independent of its spatial position and of the direction in which it is oriented using cues about the degree to which the environment diverges from symmetry (its 'slope') and about the perceptual centre of gravity of this cues (its 'centroid'). (To further muddy the waters, O'Keefe (1993) has claimed that his model of the hippocampal spatial function instantiates the Kantian spatial a priori!)

Answer

There are two things to be said here. First there is the issue of whether O'Keefe's model actually demonstrates that the animal represents absolute space alone. John Campbell (1993) has suggested that it does not and has argued, among other things, that O'Keefe (1993) overstates the differences between his slope/centroid model and the 'triangulation' model of Wilkie and Palfrey (1987) in which there is a role for bodily-centred computations. Second, there is the broader issue of the necessary interdependence of perspectival experience/re-experience of an environment and a mental map of it. These must inter-depend at some level, as a perspective is useless as a guide to behaviour without the accompanying knowledge that it is a view of something that has its own perspective-independent character. To put the matter as a Kantian cartoon,⁴ "egocentric computations without allocentric are empty; allocentric computations without egocentric are blind". Or in a un-Kantian way: 'A map is useless unless you know where you are located on it and what it means to perceive its elements

from different positions'. The exact way in which egocentric and allocentric information have to interact is difficult to determine, but at least the point is generally agreed that *the hippocampus is crucial to both episodic memory and spatial representation, which is surely good for our position.*

3. Applying perspectivism to developmental research

In this section we explore the empirical cash-value of perspectivism by applying it to some studies which seem to have the potential for telling us about the development of episodic memory.

3.1. Deferred imitation

Some studies of deferred imitation in young children are indeed studies of event memory. For example, children of 14 months will reproduce the highly un-natural action of turning on a light-box by applying pressure with the forehead rather than the hand (Meltzoff, 1988), which suggests that they are recalling the modelled action rather than learning the affordance of the object—namely that it will light up when pressure is applied to it. That patients with brain traumas that have resulted in impairments in declarative, rather than procedural, memory are also impaired on deferred imitation tasks (McDonough, Mandler, McKee, & Squire, 1995) lends further credence to the idea that these tasks do indeed tap event recall. However experiments of this kind do not assess the child's memory for their sensory (e.g., spatial) relation to the event and so fail as tests of episodic memory for this reason. This is not to say of course that experiments on deferred imitation could not involve a spatio-temporal element, indeed we counsel that they should.

3.2. Witnessed changes of state

Broadly speaking, events involve a change of state in the external world. Given this, if a child recalls a change of state of some kind then this may well be event memory, and it is potentially episodic memory. This was the rationale behind a study of change-of-state memory in toddlers (Russell & Thompson, 2003). But even setting aside the fact that the data suggested location-of-object memory was being employed rather than event memory, the event memory in the experiment (witnessing a toy being removed from one of a number of boxes) did not require the child to recall the event in relation to him/herself as an experiencer of it. However, witnessed-changes-of-state experiments could require children to code their spatial orientation in relation to the change, much as they have been in some A-not-B search tasks in infants (Bremner, 1978).

3.3. Free recall

Tulving (1985) argued that free recall depends much more heavily than does cued recall on episodic traces; and indeed adults are more likely to say that they 'remember' items in free recall than under cued recall, in which they are more likely to report them as 'known'. (Gardner, 1988). Building on this, Perner and Ruffman (1995) examined the relation, in children between 3 and 5 years, between their free recall (versus cued recall) ability and their understanding of the seeing-leads-to-knowing principle. They found that performance on seeing-leads-to-knowing tasks (comprising tests of justifying how they knew something and tests of whether they knew something or had just guessed right) correlated with free-recall performance, and not with cued recall, when age, verbal intelligence and cued-recall performance had been partialled out. Perner explained this result by claiming that a conceptual grasp of the earlier-perceived—later-known relationship is what underlies the development of episodic memory.

⁴ This is echoing Kant's famous 'Thoughts without intuitions are empty; intuitions without concepts are blind'.

Perspectivism has no foothold here, as the conceptual foundation of the study is the assumption that free recall taps episodic memory. While that assumption may well be correct it does not address the kinds of questions about the contents of episodic traces that the perspectivism approach addresses.

But the pattern of correlations found in the study has still to be explained. If we do not adopt Perner's own theory-exercising account in which a conceptual grasp of see-know determines episodic ability, then there are at least two options open to us. First, McCormack (2001) has argued that seeing-leads-to-knowing tasks are a measure of meta-memorial ability and that children with better meta-memorial abilities will tend to be better at free recall as they will have more recall strategies at their disposal. Alternatively, we can begin the explanation by saying that the see-know relationship is bi-directional: not only does seeing lead to knowing, but knowing also implies having seen (as argued by Russell, 2007). Accordingly, if a child who is good at answering the see-know questions has a feeling of knowing about a certain item then he or she will tend to say that it had been encountered.

3.4. Direct-indirect exposure studies, aspectuality, and source memory

We now discuss some of the more recent work from Perner's laboratory. This time, perspectivism is indeed in play. In this work (Perner, Kloo, & Stöttinger, 2007; other studies reviewed in Perner, Kloo, & Gornik, 2007b) 3- to 6-year-old children are exposed to a set of pictures in one of two ways: (1) they experience them directly as they put them into a box one-by-one; (2) they know of them indirectly because they were blindfolded at the time of putting them into the box and subsequently saw the placements on a video recording. The authors found that only recall accuracy of directly experienced events increased with theory-of-mind (ToM) competence. Also, in a review of empirical work on the relation between episodic and ToM abilities Perner, Kloo, and Gornik (2007) report that, while performance on the classic *unexpected transfer* (or 'false belief') task is a poor predictor of episodic recall (e.g. in the *direct-indirect exposure* studies) because unexpected-transfer performance tends to be at ceiling in the 3–6 years range, there are a number of tasks that do correlate substantially with episodic recall. These correlates include what Perner terms *knowledge source tasks*. These can require the children to say when a fact was learned, in terms of whether they have always known it or only just now (*when learned*), or whether or not they think they know something or are guessing (*know-guess*). Otherwise, knowledge source tasks consist of tests of *aspectuality*, in which the child is asked which modality is needed to find out an object's (say) colour or weight. The other correlates consist of tests of 'mental representation' (e.g., the *Smarties task*, in which the child must report on his or her own past false belief about the contents of a sweet-container, which turned out to contain a pencil not sweets) and tests of 'introspection' (*mental rotation*). Why do these correlations exist? For Perner, Kloo, and Stöttinger (2007, pp. 267–8) what the episodic and certain other ToM measures have in common is that they both require 'introspection', in the sense of an ability to generate and inspect a mental image while at the same time appreciating its representational status.

On the present view, however, what the direct-indirect exposure task and certain ToM tests require is the ability to recall or appreciate how one is perspectively related to information. In the direct-indirect exposure task, what the good recallers of their direct experience are recalling, in the first place, is their direct visuo-spatial access to the items as they were being put into the box. In the indirect case such a perspectival relation does not exist because they were blindfolded at the time.

We shall now discuss what might, on the present view, underlie the correlations between episodic recall, on the one hand, and what Perner terms tests of knowledge source, tests of mental representation and tests of introspection. We argue that what all of these have in common is that they require perspectivism.

3.4.1. Tests of knowledge source (*when learned*, *know-guess*, *aspectuality*)

We argue that the 'when learned' and the 'know-guess' tests are done by using episodic traces and that the more vivid the trace the easier they will be. In other words, performance on these tasks correlates with episodic abilities because they *are* tests of episodic ability. These memories may involve recalling learning new words on the table over there just recently or remembering that one actually *saw* the toy being put in one of the boxes, and therefore concluding one knows its location. The aspectuality task makes a rather different kind of challenge in testing for the child's grasp of his or her possible sensory relation to objects. As we argued above, reporting on the sensory modality within which information was picked up requires the perspectivism inherent in episodic experience. Children who have this relational experience will, we suggest, tend to be alive to the possibility and necessity of certain sensory relations (i.e., that colours are seen, weight is felt). It is important to stress, by the way, that while tests of aspectuality are conceptual tasks that tap the ability to reflect on perspectivism, tests of source memory (e.g., did you see or hear this known fact?) are direct tests of episodic recall itself. We shall return to source memory right at the end, in the context of animal memory.

3.4.2. Mental representation (*the Smarties task*)

In this case, the more vivid the child's episodic trace of seeing a box containing Smarties (without the unexpected contents visible) on their first encounter the more likely this is to be recruited when being asked about what one "first thought", or about what another person is likely to think. So we are arguing again that the episodic and the ToM tasks correlate because a strong episodic trace will underpin success on the ToM task.

3.4.3. Introspection (i.e., *mental rotation*)

Here, the child manipulates his or her visuo-spatial *relation* to an imagined object. Those who have a firm grasp of how one's viewpoint can stand in different relations to objects in mentally represented reality will be likely to be more skilled at this manipulation.

In sum, we are arguing that Perner, Kloo, and Stöttinger's (2007) recent episodic measure (direct-indirect access) gauges children's perspectival ability to recall their direct visuo-spatial access to objects, while the correlates either test for the ability to recruit episodically represented information or to understand and manipulate the perspectival relation between self and objects.

4. Taking stock and thinking of new experiments

We hope to have made a case for a minimalist, perspectivist view of episodic memory within which it is natural to ascribe episodic memory to animals and from the platform of which one can see a pattern in the mosaic of putatively episodic abilities in children. But of course a 'view' of something psychological is not useful unless it inspires novel empirical studies. We will now sketch just two of these.

4.1. Animals

One way of testing for source memory in animals would be by recruiting the uncertainty monitoring paradigm that Hampton

(2001) used to demonstrate that rhesus monkeys know what they remember. The basic idea would be to train the animal, be it a scrub-jay or a monkey, on a delayed-matching-to-sample (DMTS) touch-screen task which consists of two phases separated by a short delay. In the study phase, the subject is presented with a sample, and then during the test phase the animal must touch the screen in order to select, from one of four stimuli, the one it has perceived before. This is usually conducted in the visual domain, but it could of course be presented in other perceptual domains, for example the auditory. In Hampton's task, a choice phase was introduced in the delay between the study phase and the test phase, so that the monkey could decide whether or not to proceed on to the test phase. If it touched the key corresponding to the test then four stimuli appeared and the monkey was only rewarded – with a highly preferred peanut – if it chose the stimulus that had appeared in the sample phase, but if it selected one of the other three stimuli then it failed to receive any reward. However, if it touched the key corresponding to 'opt out' then a less preferred primate pellet was delivered so the animal was guaranteed to receive food.

The idea was that if the animal was certain of what it had seen in the previous study phase (i.e., knew that it had remembered well) then it should select the test key in order to receive a peanut provided its choice of stimuli was correct; but if it was less confident then it should select the safe 'opt out' option of receiving the less-valued primate pellet. In order to ensure that these responses reflected what the animal knows it does or does not remember, two things must be done. The first is to show that these responses transfer to novel stimuli, not just the ones it was initially trained with. The second is to show that *task performance in the test phase is superior when the animal can choose whether or not to take the test than when there is no 'opt out' option, and the animal is forced to take the test.*

In order to test whether our subjects have remembered the source of the stimuli, namely whether the stimuli were presented in the visual or auditory domain, one could adopt a similar procedure. Here, however, the animals would be trained on two versions of the DMTS touch-screen task, one using visual stimuli and one using auditory stimuli. In both cases the animals would have the choice of whether or not to take the memory task. One might imagine for example that for the task using visual stimuli for the DMTS they could be presented with the choice of a red key on the lower right of the screen denoting 'choose to take the memory test' and a white 'opt out key' on the left; and similarly for the version using auditory stimuli for the DMTS, there might be a blue 'choose to take the memory test' on the upper right of the touch screen and a white 'opt out key' on the left. In this way the modality information is incidental to the training procedure, but the red key is always presented for the test phase with visual stimuli and the blue key for the test phase with the auditory stimuli.

Then, at test, having been presented with either an auditory or a visual sample, the animal is presented with *all three* keys—red, blue and white. If the animal knows what it has remembered and the modality in which the stimuli were presented then it should select the corresponding key, red in the case of a visual sample stimulus and blue in the case of an auditory sample stimulus. The crucial point here is that if the animals do better when they can choose between the three keys, as compared with the case in which they are forced to pick blue-versus-white or red-versus-white, then one might conclude that they knew about the quality of their memories relative to whether their modality was visual or auditory.

4.2. Children

Here we address the question of whether a child can recall an event as from his or her own spatial perspective. The prob-

lem with such a question is that any memory, not just episodic, will necessarily contain the information to which the subject has been perspectively exposed. For example, it is trivially true that a subject will recall a half-red-half-green block as red, or green, or red-and-green depending on which single viewpoint was taken up. Given this, what is required is a task in which the child has to *identify herself* in a recording of the event, using only information about her position *vis-à-vis* the event. At time-one the child witnesses an event in a room (e.g., a machine doing something triggered by remote control). The child observes from one side. At time-two the child is shown a recording of the event with a pixelated figure to the side observing, which may be the child or a peer. Identification of self versus other can only be achieved here by noting the spatial perspective from which the event was being observed, which will be varied between children. In this task then, the perspectival demands require a representation of self-relative-to-event sufficiently explicit to enable identification of the former from its relation to the latter.

4.3. To conclude

We believe that Endel Tulving's introduction of the notion of episodic memory into psychology in 1972 was at least as instrumental in the undermining behaviourism as was 'the Chomskyan revolution'. It brought *experience* back into psychology. We have been arguing that if psychologists think harder about what should count as re-experiencing then they can quite naturally think of animals as capable of it.

Acknowledgements

We would like to thank Bob Hanna, Quassim Cassam and Tim Bussey for helpful discussion.

References

- Agster, K. L., Fortin, N. J., & Eichenbaum, H. (2002). The hippocampus and disambiguation of overlapping sequences. *Journal of Neuroscience*, *22*, 5760–5768.
- Babb, S. J., & Crystal, J. D. (2005). Discrimination of what, when, and where: Implications for episodic-like memory in rats. *Learning and Motivation*, *36*, 177–189.
- Babb, S. J., & Crystal, J. D. (2006a). Discrimination of what, when, and where is not based on time of day. *Learning & Behavior*, *34*, 124–130.
- Babb, S. J., & Crystal, J. D. (2006b). Episodic-like memory in the rat. *Current Biology*, *16*, 1317–1321.
- Bermúdez, J. (2003). *Thinking without words*. Oxford: Oxford University Press.
- Bird, L. R., Roberts, W. A., Abrams, B., Kit, K. A., & Crupi, C. (2003). Spatial memory for food hidden by rats (*Rattus norvegicus*) on the radial maze: Studies of memory for where, what, and when. *Journal of Comparative Psychology*, *117*, 176–187.
- Bremner, G. (1978). Egocentric versus allocentric spatial coding in nine-month-old infants: Factors influencing the choice of code. *Developmental Psychology*, *14*, 346–355.
- Brewer, B. (1999). *Perception and reason*. Oxford: Oxford University Press.
- Campbell, J. (1993). The role of physical objects in spatial thinking. In N. Eilan, R. McCarthy, & B. Brewer (Eds.), *Spatial representation: Problems in philosophy and psychology*. Oxford: Blackwell.
- Cassam, Q. (2007). *The possibility of knowledge*. Oxford: Oxford University Press.
- Clayton, N. S. (1999). What animals can remember about past events: An ethological approach. In W. E. Crusio & R. Gerlai (Eds.), *Recombinant DNA techniques in Behavioral Neuroscience* (pp. 614–626). Amsterdam: Elsevier [Chapter 4.2].
- Clayton, N. S., Bussey, T. J., & Dickinson, A. (2003). Can animals recall the past and plan for the future? *Nature of Review and Neuroscience*, *4*, 685–691.
- Clayton, N. S., Dally, J. M., & Emery, N. J. (2007). Social cognition by food-caching corvids: The Western scrub-jay as a natural psychologist. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences*, *362*, 507–522.
- Clayton, N. S., & Dickinson, A. (1998). Episodic-like memory during cache recovery by scrub jays. *Nature*, *395*, 272–274.
- Clayton, N. S., & Dickinson, A. (1999). Memory for the content of caches by scrub jays (*Aphelocoma coerulescens*). *Journal of Experimental Psychology-Animal Behavior Processes*, *25*, 82–91.
- Clayton, N. S., Emery, N. J., & Dickinson, A. (2006). The rationality of animal memory: The cognition of caching. In S. Hurley & M. Nudds (Eds.), *Rational animals?* (pp. 197–216). Oxford: Oxford University Press [Chapter 9].
- Clayton, N. S., Griffiths, D. P., Emery, N. J., & Dickinson, A. (2001). Elements of episodic-like memory in animals. *Philosophical Transactions of the Royal Society of London Series B*, *356*, 1483–1491.

- Clayton, N. S., Yu, K. S., & Dickinson, A. (2001). Scrub jays (*Aphelocoma coerulescens*) form integrated memories of the multiple features of caching episodes. *Journal of Experimental Psychology-Animal Behavior Processes*, 27, 17–29.
- Clayton, N. S., Yu, K. S., & Dickinson, A. (2003). Interacting cache memories: Evidence for flexible memory use by Western scrub-jays (*Aphelocoma californica*). *Journal of Experimental Psychology-Animal Behavior Processes*, 29, 14–22.
- Curry, R. K., Peterson, A. T., & Langen, T. A. (2002). Western Scrub-Jay. *The Birds of North America*, 712, 1–35.
- de Kort, S. R., Dickinson, A., & Clayton, N. S. (2005). Retrospective cognition by food-caching Western scrub-jays. *Learning and Motivation*, 36, 159–176.
- Dere, E., Huston, J. P., & De Souza Silva, M. A. (2005). Episodic-like memory in mice: Simultaneous assessment of object, place and temporal order memory. *Brain Research Protocols*, 16, 10–19.
- Dally, J. M., Emery, N. J., & Clayton, N. S. (2005). Cache protection strategies by Western scrub-jays: Implications for social cognition. *Animal Behavior*, 70, 1251–1263.
- Dally, J. M., Emery, N. J., & Clayton, N. S. (2006). Food-caching western scrub-jays keep track of who was watching when. *Science*, 312, 1662–1665.
- Eacott, M. J., & Norman, G. (2004). Integrated memory for object, place, and context in rats: A possible model of episodic-like memory? *Journal of Neuroscience*, 24, 1948–1953.
- Emery, N. J., & Clayton, N. S. (2001). Effects of experience and social context on prospective caching strategies by scrub jays. *Nature*, 414, 443–446.
- Emery, N. J., & Clayton, N. S. (2004). The mentality of crows. Convergent evolution of intelligence in corvids and apes. *Science*, 306, 1903–1907.
- Ergorul, C., & Eichenbaum, H. (2004). The hippocampus and memory for “what,” “where” and “when”. *Learning & Memory*, 11, 397–405.
- Evans, G. (1982). *Varieties of reference*. Oxford: Clarendon Press.
- Fortin, N. J., Wright, S. P., & Eichenbaum, H. (2004). Recollection-like memory retrieval in rats is dependent on the hippocampus. *Nature*, 431, 188–191.
- Gardner, J. (1988). Functional aspects of recollective experience. *Memory and Cognition*, 16, 309–313.
- Griffiths, D., Dickinson, A., & Clayton, N. S. (1999). Episodic memory: What can animals remember about their past? *Trends in Cognitive Sciences*, 3, 74–80.
- Guy, P. (2004). Kant, Immanuel. In E. Craig (Ed.), *Routledge encyclopaedia of philosophy*. London: Routledge.
- Hampton, R. (2001). Rhesus monkeys know when they remember. *Proceedings of the National Academy of Sciences*, 98, 5359–5362.
- Hampton, R. R., Hampstead, B. M., & Murray, E. A. (2005). Rhesus monkeys (*Macaca mulatta*) demonstrate robust memory for what and where, but not when, in an open-field test of memory. *Learning and Motivation*, 36, 245–259.
- Hanna, R. (2008). Kantian non-conceptualism. *Philosophical Studies*, 137, 41–64.
- Hulme, C., & Mackenzie, S. (1992). *Working memory and severe learning difficulties*. Hove, UK: Lawrence Erlbaum.
- Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, 114, 3–28.
- Johnson, M. K., Kounios, J., & Reeder, J. A. (1994). Time-course studies of reality monitoring and recognition. *Journal of Experimental Psychology*, 20, 1409–1419.
- Kant, I. (1992/1770). Concerning the ultimate ground of the differentiation of directions in space. In I. Kant (Ed.), *Theoretical philosophy 1755–1770* (pp. 373–416, Ak 2, 385–419). Cambridge: Cambridge University Press [Translated by D. Walford and R. Meerbote].
- Kant, K. (1781/1998). In P. Guyer, & A. W. Wood (Translated and Eds.), *The critique of pure reason*. Cambridge UK: Cambridge University Press.
- Kart-Teke, E., De Souza Silva, M. A., Huston, J. P., & Dere, E. (2006). Wistar rats show episodic-like memory for unique experiences. *Neurobiology of Learning and Memory*, 85, 173–182.
- McCormack, T. (2001). In C. Hoerl & T. McCormack (Eds.), *Attributing episodic memory to animals and children*. Oxford: Oxford University Press.
- McDonough, L., Mandler, J. M., McKee, R. D., & Squire, L. R. (1995). The deferred imitation task as non-verbal measure of declarative memory. *Proceedings of the National Academy of Sciences*, 92, 7580–7584.
- McDowell, J. (1994). *Mind and world*. Cambridge, MA: Harvard University Press.
- McKenzie, T. L. B., Bird, L. R., & Roberts WA. (2005). The effects of cache modification and food retrieval behaviour by rats. *Learning and Motivation*, 36, 260–278.
- Meltzoff, A. N. (1988). Infant imitation after a one-week delay. Long-term memory for novel acts and multiple stimuli. *Developmental Psychology*, 24, 470–476.
- Naqshbandi, M., Feeney, M. C., McKenzie, T. L. B., & Roberts, W. A. (2006). Testing for episodic-like memory in rats in the absence of time of day cues: Replication of Babb and Crystal. *Behavioural Processes*, 74, 217–225.
- Norman, G., & Eacott, M. J. (2005). Dissociable effects of lesions to the perirhinal cortex and postrhinal cortex on memory for context and objects in rats. *Behavioural Neuroscience*, 119, 557–566.
- Perner, J. (2001). Episodic memory: Essential distinctions and developmental implications. In C. Moore & K. Lemmon (Eds.), *The self in time*. Mahwah, NJ: Erlbaum.
- Perner, J., Kloof, D., & Stöttinger, E. (2007). Introspection and remembering. *Synthese*, 159, 253–270.
- Perner, J., Kloof, D., & Gornik, E. (2007). Episodic memory development: Theory of mind is part of re-experiencing events. *Infant and Child Development*, 15, 25–51.
- Perner, J., & Ruffman, T. (1995). Episodic memory and autoegetic consciousness: Developmental evidence and a theory of childhood amnesia. *Journal of Experimental Child Psychology*, 59, 516–548.
- Pinker, S., & Jackendoff, R. (2005). The faculty of language: What’s so special about it? *Cognition*, 95, 201–236.
- O’Keefe, J. (1993). Kant and the sea horse: An essay in the neurophilosophy of space. In N. Eilan, R. McCarthy, & B. Brewer (Eds.), *Spatial representation: Problems in philosophy and psychology*. Oxford: Blackwell.
- O’Keefe, J., & Nadel, L. (1978). *The hippocampus as a cognitive map*. Oxford: Oxford University Press.
- Peacocke, C. (2001). Does perception have a nonconceptual content? *Journal of Philosophy*, 98, 239–264.
- Roberts, W. A., Feeney, M. C., MacPherson, K., Petter, M., McMillan, N., & Musolino, E. (2008). Episodic-like memory in rats: Is it based on when or how long ago? *Science*, 320, 113–115.
- Russell, J. (1996). *Agency: Its role in mental development*. Hove, UK: The Psychology Press.
- Russell, J. (1999). Cognitive development as an executive process—in part: A homeopathic dose of Piaget. *Developmental Science*, 2, 247–295.
- Russell, J. (2007). Controlling core knowledge: Conditions for the ascription of intentional states to self and others by children. *Synthese*, 159, 167–196.
- Russell, J., & Thompson, D. (2003). Memory development in the second year: For events or locations? *Cognition*, 87, B97–B105.
- Salwiczek, L. H., Dickinson, A., & Clayton, N. S. (2008). What do animals remember about their past? In R. Menzel (Ed.), *Cognitive psychology of memory* (pp. 441–459). Amsterdam: Elsevier.
- Salwiczek, L. H., Dickinson, A., & Clayton, N. S. (2008). What do animals remember about their past? In J. H. Byrne (Ed.), *Vol. 1 of Learning & memory: A comprehensive reference, 4 vols*. Amsterdam: Elsevier.
- Schwartz, B. L., & Evans, S. (2001). Episodic memory in primates. *American Journal of Primatology*, 55, 71–85.
- Steele, M. A., Turner, G., Smallwood, P. D., Wolff, J. O., & Radillo, J. (2001). Cache management by small mammals: Experimental evidence for the significance of acorn embryo excision. *Journal of Mammalogy*, 82, 35–42.
- Suddendorf, T., & Corballis, M. C. (1997). Mental time travel and the evolution of the human mind. *Genetic Social and General Psychology Monographs*, 123, 133–167.
- Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel and is it unique to humans? *Behavioral and Brain Sciences*, 30, 299–351.
- Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organisation of Memory* (pp. 381–403). New York: Academic Press.
- Tulving, E. (1983). *Elements of episodic memory*. Oxford: Clarendon Press.
- Tulving, E. (1985). Memory and consciousness. *Canadian Psychology*, 26, 1–12.
- Tulving, E. (2000). Concepts of memory. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 33–43). Oxford: Oxford University Press.
- Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, 53, 1–25.
- Tulving, E. (2005). Episodic memory and autoeosis: Uniquely human? In H. S. Terrace & J. Metcalfe (Eds.), *The missing link in cognition. Origins of self-reflective consciousness* (pp. 3–56).
- Wilkie, D. M., & Palfrey, R. (1987). A computer simulation of rats’ place navigation in the Morris water maze. *Behavioural Brain Research Methods Instruments and Computers*, 19, 400–403.
- Zentall, T. R., Clement, T. S., Bhat, R. S., & Allen, J. (2001). Episodic-like memory in pigeons. *Psychonomics B Review*, 8, 685–690.
- Zinkivskay, A., Nazir, F., & Smulders, T. V. (in press). What–Where–When memory in magpies (*Pica pica*). *Animal Cognition*.