

Rethinking the Definition of Episodic Memory

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The definition of episodic memory, as proposed by Tulving, includes a requirement of conscious recall. As we are unable to assess this aspect of memory in nonhuman animals, many researchers have referred to demonstrations of what would otherwise be considered episodic memory as “episodic-like memory.” Here the definition of episodic memory is reconsidered based on objective criteria. While the primary focus of this reevaluation is based on work with nonhuman animals, considerations are also drawn from converging evidence from cognitive psychology, neuropsychology, and cognitive neuroscience. Implications of this rethinking are discussed, as well as considerations of familiarity, indirect measures of memory, and generally what should be viewed as necessary for episodic memory. This perspective is intended to begin an iterative process within the field to redefine the meaning of episodic memory and to ultimately establish a consensus view.

Public Significance Statement

Being able to remember our past experiences, such as the specific event details from a recent dinner with friends or when you moved to a new city, rely on episodic memory. Based on the conventional definition proposed by Endel Tulving decades ago, only humans have episodic memory and it is inexplicably intertwined with consciousness and introspection. Here I suggest we rethink this definition based on criteria that can be externally verified and objectively evaluated.

Keywords: episodic memory, nonhuman animals, recollection, hippocampus

Most of us can think back to the previous week (e.g., a recent dinner with friends) and events of importance (e.g., moving to a new place) without much difficulty. Can nonhuman animals engage in similar behaviour? By the current definition of episodic memory, this inability to peer into the introspective behaviours of nonhuman animals means we can only ascribe evidence of “episodic-like” memory to them. This approach seems overly limited and anthropocentric. Here I suggest that we shift toward more objective criteria for defining episodic memory that do not rely on introspection or necessitate conscious recollection. The implications of this rethinking are discussed, as well as considerations of familiarity, indirect measures of memory, and generally what should be viewed as necessary for episodic memory. Episodic memory is studied in a variety of subfields within psychology, including cognitive psychology, neuropsychology, and cognitive neuroscience, in addition to comparative psychology. In this article, I draw from converging evidence from all of these subfields to suggest a path forward that may be consistently and broadly used. By adopting a new definition that can be externally verified, objectively evaluated, and less reliant on self-report,

episodic memory can be more consistently assessed across a variety of subfields. This perspective is intended to begin an iterative process within the field to redefine the meaning of episodic memory and to ultimately establish a consensus view.

The current definition of episodic memory, as described in (Tulving, 2002), includes a rich characterisation of the concept:

Episodic memory is a recently evolved, late-developing, and early deteriorating past-oriented memory system, more vulnerable than other memory systems to neuronal dysfunction, and probably unique to humans. It makes possible mental time travel through subjective time, from the present to the past, thus allowing one to reexperience, through autoeotic awareness, one’s own previous experiences. Its operations require, but go beyond, the semantic memory system. Retrieving information from episodic memory (remembering or conscious recollection) is contingent on the establishment of a special mental set, dubbed episodic “retrieval mode.” Episodic memory is subserved by a widely distributed network of cortical and subcortical brain regions that overlaps with but also extends beyond the networks subserving other memory systems. The essence of episodic memory lies in the conjunction of three concepts: self, autoeotic awareness, and subjectively sensed time. (p. 5)

Critically, Tulving drew a direct and unambiguous correspondence between systems of memory (episodic, semantic, and procedural) and the involvement of consciousness, with episodic memory corresponding to autoeotic (self-knowing) consciousness. Based on this definition, often it is suggested that animals have “episodic-like memory,” rather than episodic memory itself,

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as it cannot be known if an animal has consciously recalled the information. Moreover, Tulving (2002) clearly states that episodic memory is “probably unique to humans,” and this definition as a whole sets up the definition of episodic memory such that it only could be available to humans, without saying that explicitly; some others have taken similar stances with episodic memory (and mental time travel) being reserved to humans (Murray, Wise, & Graham, 2017; Roberts, 2002; Suddendorf & Busby, 2003; Suddendorf & Corballis, 2007). Even with regard to episodic memory in (human) children, some memory researchers take a relatively strict view that may be limited by language comprehension—thus attributing a relatively later age for the onset of episodic memory abilities (e.g., Friedman, 1991; Roberts, 2002), while others consider a more minimal definition of reexperiencing (e.g., Bauer & Leventon, 2012; Clayton & Russell, 2009). Here I suggest that Tulving’s definition of episodic memory is overly anthropocentric and that we should drop the use of “episodic-like” memory. To implement this modification, we need to reevaluate our definition of episodic memory to be independent of conscious recall and shift to criteria that can be externally verified and objectively evaluated, rather than rely on introspective reports. Thus, the approach proposed here is to disentangle consciousness from the definition of episodic memory and adopt methods that are more objective (e.g., source-memory test vs. remember/know procedure), as well as turn to neuropsychological dissociation findings, to remove this dependency. This is not necessarily to suggest that episodic memory and consciousness are not related, but rather to allow for separations in their definitions that can be individually evaluated independently and rely less on anthropocentric thinking. Admittedly, Tulving (2005) makes a similar argument, but in the opposite direction—suggesting that it is anthropocentric to think that animals’ memory works similarly to our own. Although I agree with the premise of this perspective, my goal is to move further toward objective tests of memory, in contrast to Tulving’s use of introspective judgments.

When first proposed, Tulving (1972, p.384) did not have a strong view of episodic and semantic memory as being distinctly different: “I will refer to both kinds of memory as two stores, or as two systems, but I do this primarily for the convenience of communication, rather than as an expression of any profound belief about structural or functional separation of the two” (p 384). Later, Tulving (1983) strengthened this distinction by suggesting that these two memory systems differed in their biological basis. In subsequent decades, Tulving shifted his view further; Tulving (2002) stated, “Episodic memory is a recently evolved, late-developing, and early-deteriorating past-oriented memory system, more vulnerable than other memory systems to neuronal dysfunction, and probably unique to humans” (p. 5). Importantly, Tulving (2002) does acknowledge that his perspective on episodic memory as a concept has changed drastically over the 30 years since his initial 1972 work, so I consider the 2002 perspective as the primary definition of episodic memory. (For a more exhaustive overview of how the concept of episodic memory has developed over the decades, see Tulving, 2002; for a brief anecdotal description of the very beginnings of the term episodic memory, see Tulving, 2016.)

To reiterate, my goal here is not to suggest that there is no distinction or continuum between episodic and semantic memory, but rather to reevaluate the definition of episodic memory and our current understanding of memory in nonhuman animals, and to

consider how we can test for episodic memory more objectively. Tulving (2002) himself comments that some other well-known memory researchers do not agree with his strong distinction between episodic and semantic memory, providing us with insight that even with a contemporary understanding of the literature, his criteria for the specific distinction between memory systems was not without issues. While others over the years have also considered these two systems of memory to be quite distinct, as has been true of many other topics in cognitive psychology, recent evidence has demonstrated that episodic and semantic memory share many attributes, lying more along a continuum, and being interdependent systems (Craig, 2000, 2020; Greenberg & Verfaellie, 2010; Renault, Irish, Moscovitch, & Rugg, 2019; Saive, Royet, Garcia, Thévenet, & Plailly, 2015).

Disentangling Episodic Memory From Consciousness

Returning to Tulving (1985), from when he first made the connection between episodic memory and consciousness,

Nowhere is the benign neglect of consciousness more conspicuous than in the study of human memory. One can read article after article on memory, or consult book after book, without encountering the term “consciousness.” Such a state of affairs must be regarded as rather curious. One might think that memory should have something to do with remembering, and remembering is a conscious experience. To remember an event means to be consciously aware now of something that happened on an earlier occasion. Nevertheless, through most of its history, including the current heyday of cognitive psychology, the psychological study of memory has largely proceeded without reference to the existence of conscious awareness in remembering. (p. 1)

Is this dependency on consciousness necessary? Perhaps it is functionally, but can we test for episodic memory independently of consciousness? This requirement of conscious recall inherently cannot be evidenced in nonhuman animals (Clayton, Griffiths, & Dickinson, 2000), leading researchers to refer to what otherwise would be considered as episodic memory in humans as “episodic-like memory” in animals. Moreover, so-called episodic-like memory has been observed in a large range of species, including nonhuman primates (Basile & Hampton, 2011; Fagot & Cook, 2006; Hoffman, Beran, & Washburn, 2009; Menzel, 2005; Schwartz & Evans, 2001; Schwartz, Hoffman, & Evans, 2005), a variety of avian species Clayton and Dickinson (1998); Clayton, Yu, and Dickinson (2001); Cook, Levison, Gillett, and Blaisdell (2005); Dally, Emery, and Clayton (2006); Fagot and Cook (2006); Feeney, Roberts, and Sherry (2009); González-Gómez, Bozinovic, and Vásquez (2011); Qadri, Leonard, Cook, and Kelly (2018); Skov-Rackette, Miller, and Shettleworth (2006); Zentall, Clement, Bhatt, and Allen (2001); Zentall, Singer, and Stagner (2008), but also dogs (Fugazza, Pogány, & Miklósi, 2016; Lo & Roberts, 2019; Sluka et al., 2018), horses (Hanggi & Ingersoll, 2009; Valençon, Lévy, Górecka-Bruzda, Calandreau, & Lansade, 2013), dolphins (Mercado, Uyeyama, Pack, & Herman, 1999), cuttlefish (Jozet-Alves, Bertin, & Clayton, 2013), rodents (Babb & Crystal, 2005; Davis, Easton, Eacott, & Gigg, 2013; Panoz-Brown et al., 2016, 2018; Zhou & Crystal, 2009), and even insects (Pahl, Zhu, Pix, Tautz, & Zhang, 2007; Perry, Barron, & Chittka, 2017). While it is possible that episodic memory is a cognitive function that is uniquely human, it is more plausible that current distinctions between episodic and episodic-like memory are so similar that it

would be more useful to view them both as episodic memory. Moreover, current evidence of episodic-like memory has been used as supportive evidence for the notion of animal consciousness (Griffin & Speck, 2004), further complicating the usefulness of the current definitions of episodic and episodic-like memory. Recent behavioural work with nonhumans, as well as plants, has further demonstrated that evaluating the presence of consciousness is a complicated topic (Carruthers, Carls-Diamante, Huang, Rosen, & Schier, 2019; Pagán, 2019; Segundo-Ortín & Calvo, 2019; Taiz et al., 2019). Indeed, without turning to self-report, it is difficult to measure consciousness in humans, as the definition of consciousness itself is nebulous at best.

While dissociating episodic memory from consciousness, it is useful to be reminded that there are terms that may benefit from increased use in the literature, particularly in more precisely characterising the link between episodic memory and consciousness. The act of conscious recollection has been termed “ecphory” (Semon, 1921; also see Schacter, Eich, & Tulving, 1978, and Schacter, 2001), although this term is often falsely attributed to Tulving (e.g., Daselaar et al., 2001; Kim, 2013; Kinoshita, 2002; Markowitsch, Calabrese, Neufeld, Gehlen, & Durwen, 1999; Markowitsch, Vandekerckhove, Lanfermann, & Russ, 2003). I do not dispute that ecphory is a cognitive process that humans can engage in, but here I suggest that conscious recall, ecphory, should not be considered as a requirement for demonstrating episodic memory ability, and consider that it is unclear whether nonhuman animals can engage in ecphory. In relation to the Tulving’s (2002) definition of episodic memory, an alternative is to consider that studies provide evidence of episodic memory either with or without ecphory.

Defining Boundaries of Episodic Memory

Apart from removing the requirement of conscious recollection, a more nuanced discussion of what should be considered as episodic memory is also warranted. An independent, but largely convergent approach may be to make this discrimination based on neurobiological, functional specialization and consider episodic memory to be hippocampal dependent. This approach has the additional benefit of being atheoretical and directly testable, and ensures that cognitive theory is linked to biology. As such, memory for items without additional contextual information, which can be remembered by amnesic patients (with hippocampal damage) in item-recognition tests (e.g., Holdstock, Mayes, Gong, Roberts, & Kapur, 2005; Holdstock et al., 2002; Mayes, Holdstock, Isaac, Hunkin, & Roberts, 2002), would not qualify as a sufficient test of episodic memory. This view is congruent with Tulving (2002), and corrects an overgeneralisation made by Tulving (1972). Nonetheless, tests of memory involving contextual information—for example, source, association, or order—would here be considered as assessing episodic memory. Additionally, tests of memory specificity, such as the mnemonic similarity task (Stark, Kirwan, & Stark, 2019; Stark, Yassa, Lacy, & Stark, 2013; Yassa & Stark, 2011), where recognition is tested for old items as well as similar items, would also be considered tests of episodic memory (i.e., if episodic memory includes a “which” component to differentiate two items that are very similar). Considerations of the experimental procedure, and potentially if the task can be accomplished with a hippocampal lesion, would sometimes be needed to distinguish

between a test of contextual memory versus, for instance, conditioned place preference. However, this is not intended to be a one-to-one mapping; while I am suggesting that episodic memory requires the hippocampus, this does not mean that the hippocampus is limited to only being involved in episodic memory or that any task that requires the hippocampus is by definition also considered an episodic memory task.

This perspective of examining contextual memory, without regard to interpreting the autoeotic properties (which is unmeasurable and introspective), is consistent with the views of many nonhuman memory researchers (e.g., Babb & Crystal, 2005; Clayton & Dickinson, 1998; Davis et al., 2013; Feeney et al., 2009; Hoffman et al., 2009; Lo & Roberts, 2019; Pahl et al., 2007; Skov-Rackette et al., 2006). More directly, hippocampal volume has been linked to memory capacity both within and across nonhuman species (e.g., Clayton, 1995; Cnotka, Möhle, & Rehkämper, 2008; Hampton & Shettleworth, 1996; Krebs, Sherry, Healy, Perry, & Vaccarino, 1989; Lee, Miyasato, & Clayton, 1998; Sherry, Vaccarino, Buckenham, & Herz, 1989; Volman, Thomas, & Schuett, 1997). While there is some convergent evidence of regional hippocampal volume correlating with memory capacity in humans (Maguire et al., 2000; Maguire, Woollett, & Spiers, 2006), this relationship may not be present as a continuous measure (see Weisberg, Newcombe, & Chatterjee, 2019). Regardless of inter-individual differences in memory capacity, the notion that memory for contextual information (what, where, when, which) is an important aspect of episodic memory and requires the hippocampus is in line with previous conceptions of episodic memory (Tulving, 1983, 1984). This view is also convergent with Clayton et al. (2000), albeit with a different rationale, although this was no longer sufficient after the addition of the requirement of autoeotic experiences by Tulving (1985, 2002). Thus, for reasons of both parsimony and objective measurement, here I propose a consistent view also be taken for human memory research—and adopted as the formal definition of episodic memory. I consider the hippocampus as being central to episodic memory based on its consistent involvement in recollection, memory for contextual information, and mental time travel. Admittedly, the hippocampus is not a unitary neurobiological structure (e.g., see Hrybowski et al., 2019; Small, 2002; Strange, Witter, Lein, & Moser, 2014), but I will not be differentiating between the hippocampal subfields or long-axis specialisation here.

Reconciling the Definition of Episodic Memory With the Broader Literature

If we are to consider a less restrictive definition of episodic memory, we must, of course, also consider the broader implications.

Is Familiarity a Type of Episodic Memory?

While we cannot ask nonhuman animals to make subjective judgments of memory recollection versus familiarity, we can, and do, with humans. One of the goals of the present work is to make considerations of the definition of episodic memory serve both. Briefly, when testing memory for individual items with humans, sometimes the participants are asked to evaluate if they can recollect qualitative details of an experience (i.e., remember) or

merely have a sense of familiarity without these richer details (i.e., knowing). In these tasks, participants are given the option of responding “remember,” “know,” or “new” for each recognition item (Dudukovic & Knowlton, 2006; Gardiner, 2001; Java, Gregg, & Gardiner, 1997; Migo, Mayes, & Montaldi, 2012; Tulving, 1985). To date, this approach to studying memory has been used in hundreds of studies.

Providing strong support for the distinction between recollection and familiarity, patients with hippocampal damage show selective impairments to recollection and associative processing (e.g., Aggleton et al., 2005; Brandt, Gardiner, Vargha-Khadem, Baddeley, & Mishkin, 2009; Giovanello, Verfaellie, & Keane, 2003; Holdstock et al., 2002; Mayes et al., 2004; Turriziani, Fadda, Caltagirone, & Carlesimo, 2004; Vann et al., 2009; Verfaellie, Koseff, & Alexander, 2000; Yonelinas, 2001). Convergent, neuroimaging studies have demonstrated greater hippocampal activation for recollection-related responses than familiarity responses (e.g., Cohn, Moscovitch, Lahat, & McAndrews, 2009; Davachi, Mitchell, & Wagner, 2003; Eldridge, Knowlton, Furmanski, Bookheimer, & Engel, 2000; Mayes et al., 2019; Ranganath et al., 2003). Providing evidence of a possible double dissociation, Brandt, Eysenck, Nielsen, and von Oertzen (2016) reported on experiments with patient M.R., who had an entorhinal cortex lesion that resulted in impaired familiarity, but intact recollection. Despite this compelling evidence, it is also important to acknowledge that lesions to other brain regions, such as in the case of semantic dementia, can also have influences on recollection and familiarity (e.g., Hodges & Graham, 2001). Recollection responses have also been associated with successful retrieval of other contextual information (e.g., what, where, when, which; e.g., Saive et al., 2015); when a simple old/new recognition task is used, recollection is often considered based on source-memory performance (e.g., Davachi et al., 2003; Ranganath et al., 2003).

Given the inherent introspective nature of asking a human participant to discriminate between “remember” and “know” responses and then mapping these to processes corresponding to recollection and familiarity, we become too reliant on self-report judgments rather than distinguishing between differences in memory representations or mechanisms. Indeed, it can be argued that greater consideration is needed to define what these terms mean in reference to cognitive representations and neurocomputational operations—see Cowell, Barense, and Sadil (2019) for a more nuanced discussion. Moreover, subjective responses are vulnerable to biases; for example, there are instances where an amnesic patient can recognise an item as well as a healthy control participant, but generally has more deficits. Here the patient may be unlikely to respond “remember” due to their general memory deficits, and this problem may also apply to other cohort differences in between-groups analyses (see Madan & Singhal’s, 2013, paper for examples in another domain of cognitive psychology).

If familiarity is not considered sufficient for episodic memory, an open question is to consider what it is instead. While familiarity is included as a type of episodic memory by some (Eldridge et al., 2000; Yonelinas, 2001), others have classified it as “non-episodic” (Dudukovic & Knowlton, 2006; Palombo, Alain, Söderlund, Khuu, & Levine, 2015) or as a type of semantic memory (Bartsch, Dohring, Rohr, Jansen, & Deuschl, 2011; Yonelinas, 2002; Yonelinas et al., 2002; Zentall et al., 2008)—including Tulving in the past (Tulving, 1985). Some have also considered familiarity as

being influenced by a mixture of both episodic and semantic memory (as well as other processes; e.g., Budson et al., 2006; Dewhurst & Hitch, 1997; Jacoby & Dallas, 1981; W. A. Johnston, Hawley, & Elliott, 1991; Migo et al., 2012; Schacter, Israel, & Racine, 1999; Wang, Brashier, Wing, Marsh, & Cabeza, 2018; Whittlesea, 1993), and this is the position most strongly supported by current evidence. This mixture view of familiarity could also be considered as a combination of both general (semantic) item familiarity (e.g., Gilhooly & Logie, 1980) and episodic memory traces, similarly to the distinction between primary and secondary distinctiveness (Schmidt, 1991). Primary distinctiveness is based on being distinct in salience/congruity within a local, episodic context (e.g., akin to an oddball or Von Restorff paradigm); secondary distinctiveness is instead in distinct relation to general knowledge or experiences, thus corresponding to semantic memory. One approach that has been demonstrated to be successful with both humans and nonhumans in decreasing the influence of familiarity in recognition procedures is to ensure that all items have been pre-familiarised such that the lures are not entirely “new” to the experimental task and to match lures as closely as possible to the old items (e.g., Brady & Hampton, 2018; Madan, Fujiwara, Caplan, & Sommer, 2017; Panoz-Brown et al., 2016).

Given this boundary criterion of familiarity being insufficient for qualifying as episodic memory, what remains and follows from dual-process theory is recollection. More broadly, this can be considered as memory for items along with contextual information, such as location, time, value, or any of a myriad of other attributes that can be considered evidence of remembered source information. Although few studies have done so, source memory can be tested in nonhuman animals (e.g., Crystal, Alford, Zhou, & Hohmann, 2013).

Which Memory Measures Evaluate Episodic Memory?

Not all memory measures are necessarily dependent on episodic memory. As already discussed, old/new recognition can be relatively spared with hippocampal damage (e.g., Holdstock et al., 2005; Holdstock et al., 2002; Mayes et al., 2002). In contrast, performance was highly impaired in recall tests. This distinction between recognition and a recall/generation process can be critical to the necessity of hippocampal engagement. With humans, it can sometimes be difficult to implement a recall test due to its requisite open-ended nature, rather than a match-to-sample recognition procedure, in some experimental settings, for example, in an MRI scanner. Nonetheless, the use of modified procedures such as a hybrid metamemory – cued recall (e.g., Caplan & Madan, 2016; Madan et al., 2017) or item-recognition – cued recall (e.g., Madan, Knight, Kensinger, & Steinmetz, 2020) procedure can be used to increase sensitivity to hippocampal engagement.

Another important distinction in memory test procedures, with humans, is the use of direct or indirect measures (M. K. Johnson & Hasher, 1987; Richardson-Klavehn & Bjork, 1988). Briefly, direct memory measures ask the participant directly to make memory-related responses, such as old/new recognition, free recall, associative recognition, or cued recall. Indirect measures, in contrast, are ones where memory may “spill over” and influence the participants’ response, but is not directly asked for, such as lexical decision, word-stem completion, or preference ratings. (Note that many would instead refer to these as explicit vs. implicit

tests of memory, but that involves an inference about the nature of memory systems themselves, rather than being a more objective characterisation of the task design.) With some consideration, both recognition and recall can be evaluated using both direct and indirect memory measures (see [Jacoby & Hollingshead, 1990](#)).

A key difference between direct and indirect measures of memory is the necessity of conscious recollection (i.e., *epchory*; [M. K. Johnson & Hasher, 1987](#)). Based on [Tulving's \(2002\)](#) definition of episodic memory, a direct test of memory that is associated with a successful memory must engage *epchory*, whereas a forgotten memory would not involve *epchory*. [Tulving's](#) definition would further suggest that indirect measures of memory cannot be based on episodic memory. However, if one were trained to associate individual words with reward values and then be presented with these words again in a lexical decision test (as in [Chakravarty et al., 2019](#); [Madan, Fujiwara, Gerson, & Caplan, 2012](#)), an influence of reward value on lexical decision response time is one based on episodic memory, not a change in the word's semantic meaning. Is this judgment on the reliance of item–value associations on episodic memory contingent on whether the participant is or is not able to explicitly recall the value of an item in a value-judgment task? This is one instance of where the current perspective's boundaries for episodic memory still remain hazy. Further complicating matters, some memory tasks can be accomplished with a mixture of different strategies, where one is likely hippocampal dependent and another relies on a different memory system (e.g., basal ganglia; e.g., [Dahmani & Bohbot, 2015](#); [Iaria, Petrides, Dagher, Pike, & Bohbot, 2003](#)).

Tests of episodic(-like) memory in animals are often recognition. Moreover, given these definitions of direct and indirect tests, all (or at least, most) tests of memory in animals would be indirect measures of memory, and are rather tests of preference. Specifically, animals cannot be instructed and memory tests are effectively reliant on past reward histories guiding choice in combination with familiarity/novelty signals. However, some studies have used more complex procedures to distinguish responses based on item–source/context associations from those that would be based on merely preference due to familiarity/recency ([Crystal et al., 2013](#); [Panoz-Brown et al., 2016](#)).

Difficulties in Testing Memory in Nonhuman Animals

When studying memory in nonhuman animals, it can be difficult to separate a test of memory from a test of choice or preference, for instance if the study involves associating items with reward outcomes (e.g., [Ludvig, Madan, Pisklak, & Spetch, 2014](#); [Madan, Ludvig, & Spetch, 2014, 2019](#); [Madan & Spetch, 2012](#)). As a result, some tasks that are relatively straightforward to conduct in humans cannot be translated to nonhuman animals.

More broadly, [Tulving \(2002\)](#) expressed that there was no evidence that nonhuman animals can engage in mental time travel. While this may have seemed more clear-cut at the time, research in the past two decades has provided evidence of mental time travel in nonhuman animals. For instance, [Clayton and Dickinson \(1998\)](#) conducted a well-designed study where scrub jays cached perishable food (wax-moth larvae) and non-perishable food (peanuts). When allowed to retrieve the stored food after a short delay, they preferred the fresh larvae. When recovering food after a long interval, the jays quickly learned to

avoid the now-decayed larvae and to instead recover the cached peanuts. This study provides relatively clear evidence that the jays not only remembered where they had cached food, but also which food was cached at each location and when it has been cached—allowing the jay to infer the fresh or decayed state in the case of the perishable larvae.

Providing a more direct example of mental time travel, we can also turn to the behaviour labelled “vicarious trial-and-error learning.” Here, researchers had observed that when navigating complex T mazes, rats would sometimes stop at the choice-point/intersections and look at either potential pathway, seemingly to deliberately consider the potential outcomes of the decision ([Muenzinger, 1938](#); [Tolman, 1939, 1948](#)). More recent work has explored this behaviour further, more explicitly linking it to prospective hippocampal firing rate activity (sometimes referred to as “preplay”) and mental time travel ([de la Prida, 2020](#); [Dragoi & Tonegawa, 2013](#); [Kay et al., 2020](#); [Ólafsdóttir, Barry, Saleem, Hassabis, & Spiers, 2015](#); [Redish, 2016](#)). While it is difficult or even impossible to gain true insight into the introspective process to which this behaviour corresponds, it is plausible that it corresponds to a conscious recollection experience. Regardless, it must be conceded that this procedure has provided more objective evidence of episodic memory than the subjective criterion that is currently used with humans based on self-report in a remember/know procedure.

Despite there being some evidence of mental time travel in nonhuman animals, this ability may not be necessary to demonstrate memory for contextual information (i.e., what, when, where, which) in these tasks in some or all other species. That is, even when mental time travel is possible, it may not be the same “strategy” used by animals when presented with a task in which a human would engage in mental time travel. While this makes interpreting behavioural findings more complex, it also provides further motivation for the development of objective, non-introspective measures of episodic memory.

A New Definition of Episodic Memory

To provide a summary of the suggestions made in this article, here I propose a new definition of episodic memory:

Episodic memory is the remembrance of one's own previous experiences and can be done by both human and nonhuman animals. Episodic memory is supported by a distributed network of cortical and subcortical brain regions, but requires the involvement of the hippocampus—unlike other memory systems. Mental time travel, the reexperiencing or imagining of a sequence of events, is dependent on episodic memory. Familiarity may involve episodic memory but is not a type of episodic memory, as familiarity is also dependent on other memory processes.

Additionally, this new definition does not require conscious recollection and there is no distinction between episodic and episodic-like memory. When possible, self-report distinctions between memory processes should be avoided (e.g., remember/know procedures) and should be instead tested using source-memory or item-strength (such as confidence ratings) procedures.

Conclusion

While there is a need for consistent definitions in the literature, there also is a need to periodically reevaluate these definitions as a facet of moving the field forward. The evidence presented here is suggestive of a less restrictive and more parsimonious view of episodic memory that can be more objectively evaluated empirically. Several takeaway messages are discussed in this article, not the least of which is that researchers of human memory may underestimate the extent of memory phenomena that can also be found in nonhuman animals, for instance, false memories (Millin & Riccio, 2019). The perspective presented here can be refined further, but hopefully represents a notable step forward in how we understand and assess episodic memory.

Résumé

La définition de mémoire épisodique, proposée par Tuving, comprend une exigence de rappel conscient. Comme nous sommes incapables d'évaluer cet aspect de la mémoire chez les animaux non humains, de nombreux chercheurs ont qualifié de « mémoire de type épisodique » les démonstrations de ce qui serait autrement considéré comme une mémoire épisodique. Ici, la définition de mémoire épisodique est réévaluée en fonction de critères objectifs. Bien que l'objectif principal de cette réévaluation repose sur le travail avec des animaux non humains, les considérations sont également tirées de données convergentes des domaines de la psychologie cognitive, de la neuropsychologie et de la neuroscience cognitive. Les répercussions de cette remise en question sont abordées, ainsi que les considérations de familiarité, les mesures indirectes de la mémoire et, de manière générale, ce qui devrait être considéré comme nécessaire pour la mémoire épisodique. Cette perspective est destinée à démarrer un processus itératif dans le domaine afin de redéfinir le sens de la mémoire épisodique et, en fin de compte, d'établir un consensus.

Mots-clés : mémoire épisodique, animaux non humains, souvenir, hippocampe.

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