Philosophical Psychology

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/cphp20

Are episodic memory and episodic simulation different in kind?

Arieh Schwartz

To cite this article: Arieh Schwartz (16 Jan 2025): Are episodic memory and episodic simulation different in kind?, Philosophical Psychology, DOI: 10.1080/09515089.2025.2451819

To link to this article: https://doi.org/10.1080/09515089.2025.2451819

Published online: 16 Jan 2025.

PHILOSOPHICAL PSYCHOLOGY
https://doi.org/10.1080/09515089.2025.2451819

Routledge
Taylor & Francis Group

Are episodic memory and episodic simulation different in kind?

Arieh Schwartz

Centre for Philosophy of Natural and Social Science, The London School of Economics and Political Science, London, UK

ABSTRACT

Simulation theory is a radical and yet increasingly popular view about episodic memory. It is the view that episodic memory and episodic simulation are the same natural kind. I argue that while simulation theory offers an important insight, it also makes an overreach. While episodic memory and episodic simulation likely reflect a common natural kind, they also differ in natural kind. They differ in natural kind because episodic memory is partly defined by projectible properties and memory trace mechanisms that episodic simulation lacks.

ARTICLE HISTORY
Received 23 September 2024
Accepted 6 January 2025

KEYWORDS
episodic memory; simulation theory; causal theory; memory trace; natural kinds

1. Introduction

I can vividly imagine visiting the Taj Mahal in the spring, even though I have never been there. I can also vividly remember walking through the Basilica di San Marco this summer. *Simulation theory* is a radical and yet increasingly popular view about *episodic memory*.[1] On this view, episodic memory is not different in kind from mere simulation of past, possible, and future events. For example, simulation theory would judge the processes by which I simulate visiting the Taj Mahal and remember visiting San Marco to be exactly the same in natural kind(s).[2] In the words of one proponent, "[t]he standard view, in short, is increasingly that episodic memory is one function of a more general episodic construction system, *a process not different in kind from imagining a range of nonactual episodes*" (Michaelian, 2016a, p. 99, added emphasis).[3] In the words of another proponent, "[f]rom a neurocognitive perspective, it is likely that an event representation is physically instantiated in the brain in *exactly the same way* irrespective of whether it is remembered or imagined" (Addis, 2018, p. 70, added emphasis). The iconoclasm of simulation theory lies in the suggestion that some

CONTACT Arieh Schwartz a.g.schwartz@lse.ac.uk Centre for Philosophy of Natural and Social Science, The London School of Economics and Political Science, London WC2A 2AE, UK

genuine instances of the natural kind *episodic memory* do not reflect the causal influence of a persisting lineage of representations derived from the particular experiences represented. These putative episodic memories are fabricated from whole-cloth at the moment of retrieval, using whatever materials are at hand.

Thus, simulation theory is often contrasted with the *causal theory* of memory. The causal theory claims that when a subject remembers a past experience, her occurrent mental representation is produced, in part, by a memory trace, or a lineage of traces, originally produced by the experience it represents. The causal theory has ancient roots, in the works of Plato and Aristotle and elsewhere (De Brigard, 2014a). The main contemporary source of causal theory is the conceptual analysis of remembering proposed by Martin and Deutscher (1966). More recently still, different versions of causal theory have been defended by Bernecker (2012), Cheng and Werning (2016), Robins (2016), and Perrin (2018), not as conceptual analysis but as empirically-informed metaphysics. I will argue that we should reject the simulation theory in its extreme form, and endorse a version of causal theory.[4] But the view I defend is different from canonical causal theory. It is not an analysis of when subjects episodically remember. In fact, it is wholly unconcerned with the epistemic features of episodic remembering – its role in providing knowledge, for example. The core of this view is merely that episodic memory is a natural kind distinguished from episodic simulation by its mechanistic underpinnings.

What is at stake in this debate? If episodic memory and episodic simulation are different in kind, failing to draw this distinction will yield a worse taxonomy—one that produces worse causal inductions and explanations. Whether a given induction or explanation is better or worse than another will be relative to the explanatory interests and purposes of a domain of inquiry (cf. Koskinen, 2020). But the arguments below should speak to the simulation theorist and not talk past him. For they will draw on evidence from the same domains of psychology and neuroscience that simulation theorists appeal to. Thus, while some philosophers argue that causal theory is correct from a normative perspective and simulation theory is correct from an empirical or descriptive perspective (Craver, 2020; McCarroll et al., 2022), I suggest that a version of causal theory is in fact correct relative to the same empirical or descriptive perspective.

This article has the following structure. Section 2 clarifies terminology. Section 3 introduces Boyd's Homeostatic Property Cluster account as a working theory of natural kinds. Section 4 reconstructs the case for simulation theory, and distinguishes the part of it that is probably true from the part of it we should probably reject. Section 5 critically evaluates a central premise of simulation theory, that natural kinds must be discontinuous, through discussion of recent arguments

that episodic and *semantic* memory are the same natural kind.[5] Section 6 argues for a causal theory of episodic memory as a homeostatic property cluster kind. Section 7 concludes. The thesis I will defend is that occurrent episodic memory and episodic simulation reflect some of the same natural kinds *but they also differ in kind*. They differ in kind because episodic memory is partially defined by projectible properties and memory trace mechanisms that episodic simulation lacks.

2. Stage setting

Terminology in the philosophy of memory is confusing, not least because the same word *memory* is used for both a mental capacity, and for the representational particulars that are its stock in trade.[6] Moreover, the latter, i.e., memor*ies*, can be either occurrent/active, or non-occurrent/inactive. The claim of simulation theory is usually (as above) that there is no difference in kind between episodic *remember-ing* and *simulating*. Grammatically, this claim concerns actions rather than states. But the best reading of this claim is, I suggest, that there is no difference in kind between occurrent episodic memories and occurrent episodic simulations.[7] In opposition to this claim, I will argue there *is* a difference in natural kind between occurrent episodic memories and occurrent episodic simulations.[8]

It may help prevent confusions later if we draw a distinction at the outset between two different conceptions of a *memory trace*. On a weak conception, a memory trace is any cognitive particular, or ensemble thereof, by means of which information first encountered in experience is made consciously available at a later time. Simulation theorists accept that episodic remembering requires memory traces in the weak sense. The material of which simulations are woven must come from some-where (cf. Suddendorf & Corballis, 2007, p. 303). Causal theorists have something stronger in mind when they say that episodic remembering relies on a memory trace(s). On causal theory, an episodic memory trace is a persisting record *of* an experience, created *by* that experience. Not just any cognitive particular or ensemble bearing experience-derived information will count. For not all information derived, (per-haps partially and circuitously,) from an experience, provides a record *of* the experience it derives from, i.e., a record of what transpired. Thus, causal theorists claim and simulation theorists deny that episodic remembering relies on memory traces in the strong sense. But everyone agrees that episodic remembering relies on memory traces in the weak sense.

3. Natural kinds: Homeostatic property clusters

Natural kinds are types of particulars, (entities, processes, or properties,) or types *of types* of such, whose grouping reflects the structure of the natural world rather than *merely* human interests (cf. Hawley & Bird, 2011; Tahko, 2022). Gold, hearts, and lightning are natural kinds. Members of these categories are objectively similar to each other in ways they are objectively different to members of other kinds.[9] The set of white things, the set of warm things, the set of Jimmy's favorite songs – these are no more natural kinds than the union of these sets would be. Such groupings do not reflect objective relations of similarity among kind members, and difference between kind members and nonmembers. Such groupings tell us more about the categorizer(s) than about the categorized.

There are many theories about what natural kinds are, and about what makes them natural. Space does not permit a survey of the field. Let us adopt Boyd's homeostatic property cluster (HPC) account as a working theory of what kind of kind episodic memory might be.[10] This choice is appropriate because the HPC account is probably the most influential theory of natural kinds, and it has been endorsed by Michaelian, the primary proponent of simulation theory, in various places (e.g., Michaelian, 2015). What makes a kind *natural*, for Boyd, is that it causally supports correct scientific inductions and explanations. Only kinds delimited by nature can do this. We cannot simply intuit kinds that will support correct scientific inductions and explanations, (alas). Therefore, identifying natural kinds is always *a posteriori*.

On the HPC theory, a natural kind is defined by "a cluster of often co-occurrent properties and ... the ('homeostatic') mechanisms that bring about their co-occurrence" (1991, p. 142). The central idea here is that kind-members' instantiation of kind-defining properties, *because of* the operation of kind-defining mechanisms, is what *causally supports* the correctness of our scientific explanations and inductions about kind members. Given the HPC framework, our central question is this. Do the projectible properties of episodic memory and/or the mechanisms that cause these properties to cluster together differ from the projectible properties and homeostatic mechanisms that characterize episodic simulation?[11] In section 5, I will argue that the answer to this question is: Yes. Considered as an HPC kind, episodic memory is defined by certain projectible properties, which cluster together because episodic memory relies on strong memory traces. Episodic simulation lacks some of these projectible properties because it lacks the homeostatic mechanism of strong memory traces. Thus, episodic simulation differs in kind from episodic memory. Ignoring this difference risks widespread inductive error. Before we get to that, let us consider the positive case for simulation theory.

4. The case for simulation theory

Simulation theory is the claim that occurrent episodic memory and episodic simulation are exactly the same in kind. It is useful to break the case for simulation theory into two parts. One part aims to show that there is a natural kind in common between occurrent episodic memory and episodic simulation. The other part aims to show that there is *no* natural kind to which occurrent episodic memory belongs but episodic simulation does not. Although the first part of the case is plausible, the second part is much less so.

4.1. The case for simulation theory: part one

The first part of the case for simulation theory can be reconstructed as follows. Versions of this argument can be found in Schacter and Addis (2007), De Brigard (2014b), Michaelian (2016a, 2016b), McCarroll et al. (2022).

4.1.1. Simulation theory: part one

(1) Occurrent episodic memory and episodic simulation rely on processes that take place in some of the same areas of the brain.
(2) Occurrent episodic memory relies on a constructive process.
(3) Episodic simulation relies on a constructive process.
(4) The best explanation of 1-3 is given by the hypothesis that the same natural kind of constructive process underlies both occurrent episodic memory and episodic simulation.
(5) No alternative hypothesis (to that expressed in 4) provides a better explanation of 1-3.

(C1) There is probably a natural kind of construction process shared by occurrent episodic memory and episodic simulation. I'd be grateful if you could format the conclusion so that it is aligned with the premises, as in a list.

I will briefly explain the steps of the argument. Premise 1 is supported by neuroimaging studies. Their central finding was that many of the brain areas active when subjects retrieve episodic memories are also active when subjects imagine possible future experiences (Atance & O'Neill, 2001; Hassabis & Maguire, 2007; Okuda et al., 2003; Schacter & Addis, 2007; Szpunar et al., 2007).[12] It is now common to acknowledge that episodic memory and episodic future simulation rely on a shared *core brain network*.[13]

Premise 2 draws support from false memory research. Work in this tradition has been accumulating since Bartlett's studies of story recollection (Bartlett, 1932). It strongly suggests that occurrent episodic

memories result from a *constructive* process that pieces together information from different experiential sources (see, e.g., Loftus & Palmer, 1974; Loftus & Pickrell, 1995; Roediger & McDermott, 1995; Schacter, 2021). For example, work in the *misinformation paradigm*, pioneered by Loftus, shows that false event information, provided after the fact, often gets incorporated into subjects' subsequent memories of the relevant events. Thus, episodic memory does not simply *reproduce* or replay past experiences. It *reconstructs* them using information from various sources.

Premise 3 rests on the thought that simulating future events must involve some process or other that constructs representations using information from various sources. "Since the future is not an exact repetition of the past, simulation of future episodes requires a system that can draw on the past in a manner that flexibly extracts and recombines elements of previous experiences" (Schacter & Addis, 773). Usually, you can't get an apt representation of an event you haven't experienced simply by reproducing a representation of an event you have.

The hypothesis that the same natural kind of constructive process underlies both episodic memory and episodic simulation makes good sense of the empirical evidence. The evidence does not exclude the hypothesis that occurrent episodic memory and episodic simulation reflect different kinds of constructive processes, that are executed by the same parts of the brain. But so far, we lack solid evidence that two different kinds of constructive processes are in play, rather than one. Accordingly, we should prefer the more economical assumption that episodic memory and episodic simulation reflect the same subordinate kind of constructive process. The first part of the case for simulation theory is plausible enough. Though relevant research is still underway.

4.2. The case for simulation theory: part two

The second part of the case for simulation theory is most closely associated with the work of Michaelian (see, e.g., 2016a, 2016b, 2022; McCarroll et al., 2022). Here is one articulation.

> [T]he simulationist offers a slippery slope argument against the necessity of appropriate causation. If we grant that remembering can occur in cases in which only a minority of the content of the retrieved representation is new, there is … no non-arbitrary reason to deny that it can occur in cases in which a majority of the content of the representation is new. And if we grant that remembering can occur in cases in which a majority of the content of the representation is new, there is … no non-arbitrary reason to deny that it can occur in cases in which the entirety of the content is new. But if we grant that

> remembering can occur in cases in which the entirety of the content of the retrieved representation is new . . . *then we can no longer require that the causal connection between the current representation and the earlier experience be sustained by a memory trace*. (McCarroll, Michaelian, & Nanay, 5, added emphasis)

The argument can be reconstructed as follows.

4.2.1. Simulation theory: part two[14]

(6) If episodic memory and episodic simulation differ in natural kind, they are distinguished by the causal dependence of episodic memory on strong memory traces.

(7) Episodic representations can be placed on a continuum according to their *representational* dependence on strong memory traces.[15]

(8) If episodic representations can be placed on a continuum according to their representational dependence on strong memory traces, then they can be placed on a continuum according to their *causal* dependence on strong memory traces.

(9) If episodic representations can be placed on a continuum according to their *causal* dependence on strong memory traces, then episodic memory and episodic simulation do not differ in kind in virtue of episodic memory's causal dependence on strong memory traces.

(C2) Episodic memory and episodic simulation do *not* differ in natural kind.

I will briefly explain the argument. We find commitment to premise 6 in various places. Proponents of simulation theory often speak as if the issue turned on whether *it is a necessary condition* on episodic remembering that it causally depends on strong memory traces. For example, in the quotation above, McCarroll and colleagues assume they need to undermine "*the necessity* of appropriate causation" (McCarroll, Michaelian, & Nanay, p. 5) added emphasis). Elsewhere, Michaelian writes,

> The tenability of continuism [i.e., simulation theory] . . . rests on the tenability of the denial of the claim that remembering requires a causal connection between the subject's current representation of a past event and his previous experience of that event, *a condition that is at the heart of the influential causal theory of memory* (Martin & Deutscher, 1966). [Michaelian, 2016b, p. 69, added emphasis]

Martin and Deutscher's theory was a conceptual analysis. Its conditions were intended as conceptually necessary for remembering. It is controversial, to say the least, whether natural kinds like episodic memory can be analyzed in terms of necessary and sufficient conditions (cf. Andonovski, 2018). Cluster kinds, for example HPC kinds, are not definable in this way (Boyd, 1991, 1999; Dupré, 1996; Slater, 2015). On the HPC theory, for example, genuine kind members can lack some of the projectible properties and/or homeostatic mechanisms that define the kinds they belong to (Boyd, 1991, pp. 142–143).[16] Thus, if episodic memory and episodic simulation are

cluster kinds, we cannot assume they are definable with necessary conditions. Thus, we cannot infer they do not differ in natural kind, simply because they do not differ in necessary conditions.[17] Nevertheless, the argument can be understood in a way, as above, that does *not* depend on the assumption that episodic memory is definable in necessary conditions. The point of the premise in question, (6 in the reconstruction above,) is merely that if episodic memory and episodic simulation differ in kind, this is (probably) because of some difference in how they tend to be brought about.

Premise 7 is advanced in light of empirical research on constructive memory (see, e.g., Michaelian, 2016a, ch. 6). For example, research in the misinformation paradigm shows that episodic representations can incorporate details from *various* experiences. The idea behind premise 7 is that the extent to which occurrent episodic representations incorporate details *not* encountered in the initial experiences they represent varies inversely with the extent to which these occurrent mental states representationally depend on strong memory traces.

Premise 8 links representational dependence to causal dependence with the claim that, insofar as occurrent episodic representations representationally depend on strong memory traces, they do not *causally* depend on strong memory traces. After all, the traditional reason why causal theorists posit strong memory traces is to explain how episodic memories are reliably (if only partially) accurate about past events (see Khalidi, 2023, p. 135; Robins, 2016).

Premise 9 gets at the following claim. If there is a difference of extent or "degree" in how much episodic memory and episodic simulation causally depend on strong memory traces, then there is no difference in kind between them because of how episodic memory relies on strong memory traces.[18] Different *kinds* of phenomena are not separated by cases that differ merely in extent or degree. Transitional forms do not separate distinct kinds. (We will return to this thought at length.)

Thus, conclusion: episodic memory and episodic simulation do not differ in kind.

We are now in position to evaluate the argument. Since there is no problem with the argument's structure, any fault lies in its content. We can accept premise 6. It is plausible, but not guaranteed, that if episodic memory and episodic simulation differ in kind, this will reflect a difference in how they rely on strong memory traces. For the sake of argument, we can also allow premises 7 and 8. Maybe, (and this is a maybe,) episodic representations can be ordered (in some rough sense) according to how much they depend, representationally and causally, on any given lineage of experience-derived memory traces. The issue I want to focus on concerns premise 9. This premise assumes that natural kinds have to be sharply divided or discontinuous. This assumption is not true when it comes to biological

natural kinds. As Dupré shows in *The Disorder of Things*, "it is very difficult to find really sharp distinctions anywhere in biology; generally there is a range of intermediate cases" (Dupré, 1996, p. 66). We can agree with proponents of simulation theory that it will probably not be possible to draw a sharp line based on etiology between all instances of episodic memory and all instances of episodic simulation. But it is completely normal for there to be intermediate, transitional forms that lie between biological natural kinds. The existence of transitional forms between natural kinds does not rule-out the *distinctness* of these kinds. I will reinforce this verdict in the next section. For the same assumption, that transitional forms exclude distinctions in natural kind, plays a central role in recent arguments that episodic memory is no different in kind to *semantic* memory.

5. Natural kinds permit transitional forms

Three significant recent articles challenge the natural kind distinction between episodic and semantic memory (Andonovski, 2020; Aronowitz, 2022; Gentry & Buckner, 2024). The arguments against the episodic-semantic distinction are similar. And we will see that they share the assumption of simulation theory that transitional forms rule-out distinctions in kind. I will focus on Gentry and Buckner's version, since it is articulated using the HPC framework we are using. This argument draws on Buckner (2016)'s notion of *transitional gradation*.[19] Bucker defines that notion as follows.

> Let "gradation" between putative kinds name the metaphysical situation in which the extension of one category blurs into the extension of another category or categories without an obvious dividing line … Gradation will furthermore be "transitional" when there are systematic uni- or bi-directional processes of modification (such as evolution, development, or learning) that govern the gradation of individuals from one to another putative kind(s). (Buckner, 2016, p. 1096)

Gentry and Buckner claim that the structure of the HPC account requires that putative natural kinds cannot be distinct if there is transitional gradation between the surface level properties *and* between the underlying homeostatic mechanisms of candidate members of the putative kinds. They put the point this way.

> The question of whether transitional gradation sinks the distinction [between episodic and semantic memory] can be recast in terms of … whether transitional gradation is found only in the distribution of surface properties … or whether it also reaches down to a continuum at the level of underlying neural mechanisms. Should there also be transitional gradation at the level of underlying mechanisms, then … the best approach accepts a new lumped superkind—and the E/S distinction, if retained at all, could only serve heuristic purposes. (Gentry & Buckner, 2024, p. 4)

Gentry and Buckner offer three lines of evidence that there *is* transitional gradation between the surface-level properties and between the underlying mechanisms of episodic and semantic memory instances: one, concerning *semanticization*; a second, concerning what they call *composition*; and a third concerning shared grid and place cell activity.[20] Given these transitional gradations, Gentry and Buckner conclude that episodic and semantic memory are no different in kind. We can reconstruct the argument as follows.

5.1. Argument from transitional gradation

(1) If there is transitional gradation between the surface-level properties *and* between the underlying mechanisms of any kinds *X* and *Y*, then *X* and *Y* are not distinct natural HPC kinds.
(2) There *is* transitional gradation between the surface level properties and between the underlying mechanisms of episodic memory and semantic memory, (as witnessed by semanticization, composition, and shared grid and place cell activity).

(C) Episodic memory and semantic memory are not distinct natural HPC kinds. I'd be grateful if the conclusion ould be formatted so that it is aligned with premises.

Both The Case for Simulation Theory: Part Two and The Argument from Transitional Gradation rest on the basic assumption that the existence of transitional forms between kinds excludes the distinctness of these kinds. This assumption is too strong. Endorsing it would lead to the elimination (or unification) of most natural kinds in biology. As Buckner (2016) rightly underscores, the processes of evolution, development, and learning are incremental. They guarantee transitional gradations between the surface level properties *and* between the underlying mechanisms of members of putatively different kinds. State-kinds of health and disease are also often separated by cases that exhibit transitional symptoms *and* underlying mechanisms. Consider, for a moment, the transitional gradation produced by natural selection. Boyd makes a helpful observation about this.

> The *necessary* indeterminacy in extension of species terms is a consequence of evolutionary theory … speciation depends on the existence of populations which are intermediate between the parent species and the emerging one. Any "refinement" of classification which artificially eliminated the resulting indeterminacy in classification would obscure the central fact about heritable variations in phenotype upon which biological evolution depends and would be scientifically inappropriate and misleading. (Boyd, 1991, p. 142, original emphasis)

Evolution by natural selection is *gradual*. It unfolds over very large numbers of very small steps.[21] Mutations, the raw materials of evolution, occur only

rarely.[22] Moreover, when mutations cause large phenotypic effects, these effects are almost always deleterious, and the responsible mutations are eliminated from the gene pool (Dawkins, 2016: ch. 6; Sterelny, 2001). There is always transitional gradation between extant biological kinds and ancestral biological kinds, both in their surface level properties and in their underlying mechanisms. Further, as Buckner (2016) notes, there are also transitional forms between different *extant* species, as witnessed by hybridism, and the phenomenon of *ring species*.[23] If the distinctness of natural kinds required discontinuity or the absence of transitional gradation, then evolved categories, such as species, would not be distinct natural kinds.[24] Given this, it is unclear what justifies Gentry and Buckner's suggestion that the HPC account explains the distinctness of different biological species (Gentry & Buckner, 2024, p. 3).

Returning our attention to cognitive kinds, it is commonly observed that neural reuse is the rule rather than the exception. Much of the same neural circuitry is involved in many different cognitive tasks (see, e.g., Khalidi, 2023, pp. 138–139; Schulz & Robins, 2023, pp. 814–815). Simulation theorists take neural reuse as evidence that the same kinds of processes underlie episodic memory and episodic simulation. Gentry and Buckner take reuse as evidence of mechanistic transitional gradation between episodic memory and semantic memory. But supposing that transitional gradation of this sort implies the non-distinctness of HPC kinds, Buckner (2016) would be right to suggest that, "philosophers of psychology should abandon discussion of kindhood, or explore non-similarity based accounts" (Buckner, 1091). For transitional gradation is widespread. But perhaps we'd be better off abandoning the assumption that transitional forms rule-out the distinctness of natural kinds. Transitional forms are everywhere, but so are natural kinds.

Let us take a moment to consider the specific example, of semanticization, favored by Andonovski (2020), Aronowitz (2022), and Gentry and Buckner (2024). It might not carry the moral these theorists see in it. According to some but not all the relevant theories, semanticization is the normal consequence of *systems consolidation*. Systems consolidation refers to interactions between the hippocampus and the neocortex, whereby events initially represented by the former become represented by the latter as well. The canonical evidence for systems consolidation is the phenomenon of *temporally graded retrograde amnesia* (TGRA) (De de & Smith, 2016). Namely, interventions that affect the hippocampus disrupt memories of recent events more severely than memories of temporally remote events. For example, after bilateral resection of his hippocampi (and portions of neighboring regions, e.g., the amygdalae) (Squire, 2009), the patient known as H.M. retained memories for events from his remote past, but not from the 11 years preceding his operation (Corkin, 1984). TGRA also results from electroconvulsive (i.e., "shock") therapy (ECT) (Fraser et al., 2008).[25]

There is a major divide between theories of systems consolidation. The traditional explanation is known as standard consolidation theory (SCT) (Squire et al., 2015). On this account, the hippocampus plays a time-limited role in storing episodic memories. The features of an episodic memory, represented by networks in the neocortex, are initially linked together via a hippocampal memory trace (Squire, 2015). Over time, replay of hippocampal memory traces during rest and sleep (Klinzing et al., 2019) causes neocortical features to become linked together directly, so that the episodic memory becomes independent of the hippocampus, and the hippocampal memory trace can be "reassigned" (cf. McClelland et al., 1995, 2020). Once consolidated in the neocortex, the episodic memory is much less prone to change.

SCT dominated research from the mid-1970's until around the turn of the millennium, and it still has its defenders (e.g., Dede & Smith, 2016). But these defenders are slowly dwindling in number (Moscovitch & Gilboa, 2024). According to critics of SCT, more sensitive episodic memory tests suggest that the event memories preserved in medial temporal amnesia have become *semanticized* and are no longer truly episodic (Moscovitch & Gilboa, 2024). Namely, these memories come to lack sensory detail, conveying more of a summary or *gist* of the event, or even merely the script or *schema* of events of its general type (e.g., meals in Italian restaurants, visits to art museums, etc.). Semanticization is the *transformation* of detailed episodic memories into more general event representations. Thus, according to multiple trace theory (MTT) (Nadel & Moscovitch, 1997, Nadel et al., 2000), and its successor theory, trace transformation theory (TTT) (Gilboa & Moscovitch, 2021; Moscovitch & Gilboa, 2024; Sekeres et al., 2018; Winocur & Moscovitch, 2011), hippocampal memory traces are always required for genuine episodic memories, regardless of their age. The neocortical memories of past events preserved in amnesia are semantic, not episodic. *The debate between partisans of SCT and partisans of MTT/TTT hinges on there being a kind distinction between episodic and semantic memories*. According to proponents of TTT, the currently most popular theory, "interactions between the hippocampus and neocortex should be maintained even for remote memories *as long as they retain their episodic nature*, with a decline in such interactions as memories lose *their episodic signature*" (Moscovitch & Gilboa, 2024, p. 1290, added emphasis.) While according to proponents of SCT, "[t]he weight of evidence from studies where lesions were restricted to the hippocampus or MTL [medial temporal lobe] indicates that *these regions are not necessary for the retrieval of truly episodic, remote autobiographical memories* . . . [These patients'] memories are *not semanticized* (according to the most sensitive tests that exist)" (Dede & Smith, 2018, pp. 125–126, added emphasis). Insisting that semanticization undermines the distinction between episodic and semantic memories makes

the debate between partisans of SCT and partisans of MTT/TTT look confused. What was at stake in that debate was precisely whether systems consolidation *transforms* memories that were of one kind, episodic, into memories of another kind, semantic. There can be an important difference in kind here, even though the postulated transformation process, semanticization, is thought to be gradual.

This section has one main upshot. The existence of transitional forms between putative natural kinds does not rule-out the distinctness of these kinds. If it did, few if any natural kinds would be left in the biological sciences. Thus, we have reason to resist the move from the existence of transitional forms between, say, episodic memory and episodic simulation, or between episodic memory and semantic memory, to the conclusion that episodic memory is no different in kind to these other phenomena. The Case for Simulation Theory: Part Two and The Argument from Transitional Gradation do not establish what they set to. But the failure of these arguments tells us little about whether episodic memory really *is* distinct in kind from episodic simulation. I argue that it is in the next section.

6. Tracing episodic memory

According to the HPC account, a kind is defined by the properties that causally support the correctness of scientific explanations and inductions about the particulars the kind term picks out, *and* the mechanism(s) that cause these properties to cluster together. I will argue that the correctness of orthodox scientific theories of episodic memory is causally supported by properties that cluster because episodic memory relies on strong memory traces.[26] Some of the relevant theories I will discuss include: the *depth of processing* framework, *synaptic consolidation theory*, *reconsolidation theory*, *standard consolidation theory, multiple trace theory*, and *trace transformation theory*. I will discuss how each theory explains projectible properties of episodic memory by appeal to strong memory traces. Every instance of episodic remembering has a multistage history that is rooted in a particular experience. An episodic simulation is the work of the moment: the concatenation of general knowledge with sensory details from any relevant source. This difference matters to scientific explanations and inductions about episodic memory.

According to the depth of processing framework, episodic memory performance will be better or worse depending on features of *encoding* (Craik, 2002; Craik & Lockhart, 1972; Craik & Tulving, 1975).[27] Namely, memory performance is better for items that subjects process *semantically*, i.e., in terms of their meaning than for other items.[28] For example, in a set of famous experiments, Craik and Tulving (1975) asked yes/no questions before presenting study words. To answer the questions, subjects would

have to consider the study items in specific ways. Three different types of questions were used. Questions about the visual appearance of the words, e.g., "is the word capitalized?", aimed to elicit *shallow* processing not focused on the words' meanings. Phonological questions, e.g., "Does the word rhyme with 'train'?", aimed to elicit a moderate depth of processing. Sentence questions, e.g., "Would the word fit in the following sentence ' '?", were intended to elicit "deep" processing focused on the meanings of the study words. Memory performance was measured via *recognition* tests.[29] In these experiments and many replications, memory performance for study items correlated closely with the depth or level of processing the items received during experience. This is known as the *levels of processing effect*. Episodic memory is such that memory performance is closely related to how subjects consider items during experience.

The prevailing explanation of the levels of processing effect is that deeper processing leads to more *elaborate* memory traces of to-be-remembered items (Craik, 2002). More elaborate traces may lead to superior retrieval because they are more distinctive than less elaborate traces, or because they are better integrated into existing knowledge structures, or both (Craik, 2002, p. 306–307). In Craik's view, "certainly something must change in the brain as a result of the initial experience, and this change must persist until remembering occurs," (Craik, 2002, p. 307). Systematic differences between the persisting neurological changes that result from experience, i.e., between memory traces, are what explain the systematic differences in episodic memory performance, i.e., the levels of processing effect. Experimenters are able to intervene on episodic memory performance by manipulating how subjects process the information they are presented during experience. This intervention during initial experience causally affects retrieval performance because the neurological changes that result from initial experience causally support retrieval performance. Insofar as episodic simulations rely only on general knowledge and sensory details not tied to the experiences they represent, they will not be manipulable via depth of processing interventions. In sum, episodic memory has a certain projectible property, manipulability via depth of processing interventions, because it relies on strong memory traces. Episodic simulation lacks this projectible property, because it does not rely on strong memory traces.

Synaptic consolidation theory, also known as *cellular consolidation theory*, is an explanation of the well-established fact that episodic memories are vulnerable to disruption or enhancement for several hours after encoding. After this initial period has elapsed, however, the same manipulations lose all their effectiveness. The explanation, according to synaptic consolidation theory, is that the stored informational component of a memory is initially stored in a *labile*, i.e., manipulable, memory trace(s).[30] Over a period of hours, however, synaptic connections grow between relevant neurons, as

a result of intracellular molecular processes. These synaptic connections are thought to store the informational content of the relevant memory in a more stable form. This process is known as *synaptic consolidation*. Synaptic consolidation can be disrupted by various procedures; for example, by injection of protein synthesis inhibitors such as anisomycin (Flexner et al., 1963), or by administration of ECT (Duncan, 1949; Squire et al., 1975) (cf. De Brigard, 2020). By contrast, *synaptic consolidation can also be enhanced*, and memory performance improved, by administration of chemical substances including stimulants, and stress hormones (Bremner et al., 2004; McGaugh, 2015; McGaugh & Krivanek, 1970). Episodic memory's possession of different properties at different times, lability, stability, etc., depends on mechanisms of memory trace formation and maintenance that are set in motion by a particular initial experience. The memory is labile when the trace is labile. The memory is more stable once the trace has been synaptically consolidated. It is by intervention on memory trace mechanisms that episodic memories can be disrupted or enhanced *in the initial period after the encoding experience*. Episodic simulations do not causally depend on the particular experiences they represent. Thus, they will not be subject to interventions during the consolidation windows following these experiences. Thus they lack some of episodic memory's projectible properties, because they do not rely on strong memory traces.

More recently, extensive evidence has also emerged for episodic memory *reconsolidation*. It has been shown that when memories are retrieved, they *return* to a labile state for a short period (Nader et al., 2000). During this time, memories are again open to disruption, update, and enhancement by way of the very same manipulations that are effective during the consolidation window, such as protein synthesis inhibitors, ECT, etc. For example, important research has begun to explore whether behavioral interventions on the reconsolidation process can be used to treat post-traumatic stress disorder (PTSD) (Drexler & Wolf, 2018). Initial results seem promising. Reconsolidation theory explains episodic memory's post-retrieval return to lability by appeal to changes in a persisting ensemble of underlying memory traces. Insofar as episodic simulations are not stored, they would not show these reconsolidation effects.

Systems consolidation is the process whereby hippocampal-neocortical interactions cause events, initially represented only in the hippocampus, to be represented in the neocortex as well. As explained above, standard consolidation theory (SCT) claims that systems consolidation causes *genuine episodic memories* to be stored in the neocortex (Squire et al., 2015; Dede & Smith, 2018). According to multiple trace theory (MTT) (Nadel & Moscovitch, 1997, Nadel et al., 2000) and trace transformation theory (TTT) (Gilboa & Moscovitch, 2021; Moscovitch & Gilboa, 2024; Sekeres et al., 2018; Winocur & Moscovitch, 2011), consolidation establishes

semanticized event representations in the neocortex, but genuine episodic memories always require the reactivation of memory traces in the hippocampus.

Simulation theory sorts ill with both SCT and TTT. According to SCT, occurrent episodic memories have a causal history leading back to a particular past experience. The experience lays down a hippocampal memory trace which, through interactions with the neocortex, encodes a new trace of the episodic memory there. Thereby, the episodic memory becomes independent of the hippocampus. Depending on when retrieval occurs, either a hippocampal trace, a neocortical trace, or both, will be reactivated. But both were ultimately established by an experience. Assuming SCT is right on the fundamental point that patients with severe medial temporal lobe damage retain genuine episodic memories of remote experiences, what plausible explanation could simulation theory give for why these subjects do not retain episodic memories of recent experiences? Different locations for episodic memory *storage* would presumably be central to any plausible explanation. But simulation theory swears-off the idea that episodic memories need be stored.

Suppose, as seems likely, that TTT rather than SCT is roughly correct. Different trace representations of an event are established concurrently, and some are more responsible than others for each occurrent memory. But whenever remembering is genuinely episodic, it relies on reactivation of memory trace representations in posterior hippocampus. Perhaps a simulation theorist will say that patients with MTL amnesia lose their episodic memory capacity because the incapacitated hippocampus is a crucial part of the constructive *machinery*, and not because it stores episodic memory traces. Perhaps. But what plausible explanation could simulation theory provide of the fact that the amnesia that results from ECT is specific to a particular period of time? In other words, why, given that after ECT, patients regain the ability to form *new* episodic memories, do they remain unable to episodically remember events from the period leading up to their treatment? Storage of episodic memory traces in the hippocampus would seem to be an important component of a plausible explanation. But simulation theory claims that episodic memories do not rely on such traces.

Central patterns of induction and explanation in memory science are causally supported by properties of episodic memory which cluster together because of episodic memory relies on strong memory traces. Episodic memory is manipulable at every stage of its trace-based lifecycle. Moreover, when an episodic memory is manipulable in some of the ways discussed above, it is a good bet it will be manipulable in the others. As simulation theorists insist, episodic simulations do not depend on strong memory traces. But for this reason, episodic simulations will lack many of

episodic memory's projectible properties. Thus, episodic simulation and episodic memory are indeed distinct natural *kinds* of phenomena, even though there may not be a sharp dividing line between their instances. There is an important causal difference between the etiology of episodic memory, and that of episodic simulations. These etiologies are open to very different patterns of manipulation and control. In sum, while episodic memory and episodic simulation likely reflect some of the same natural kinds (as in simulation theory: part one), they also differ in natural kind (contra simulation theory: part two).

7. Conclusion

Simulation theory says that episodic memory is just imagination of past experiences (carried out by a properly functioning episodic construction system). Michaelian acknowledges that, "[i]n many cases, remembering no doubt involves the sort of continuous causal connection described by the classical causal theory", but he insists that, "it need not" (Michaelian, 2016a, p. 111). Rather, according to simulation theory, "[w]hat it is for a subject to remember . . . is for him to imagine an episode belonging to his personal past. And imagining need not draw on stored information ultimately originating in experience of the relevant episode" (Michaelian, 2016a, p. 111.). I have been arguing that occurrent episodic memory, as a natural kind, should not be theorized independently of the normal lifecycle that leads up to it. This lifecycle is, in large part, one of memory traces, laid down by an experience, maintained over time, reactivated during remembering, reconsolidated afterward. This lifecycle is part of what defines episodic memory, because it causally accounts for many of episodic memory's projectible, causal-induction-and-explanation-supporting properties. As episodic simulation is not tied by memory traces to any one experience, in particular, it will lack many of episodic memory's projectible properties. Thus, episodic simulation is not the same as episodic memory. It is in the nature of episodic memory to be born of a past experience.

Notes

1. Roughly speaking, episodic memory is detailed memory about personally experienced events.
2. That is, provided the simulation issues from a properly functioning episodic construction system (Michaelian, 2016a, Ch. 6).
3. An anonymous reviewer suggests that this exaggerates the popularity of simulation theory.
4. This version of causal theory is consistent with a *moderate* form of simulation theory on which *some* but not all of the same subordinate natural kinds are involved in episodic memory and episodic simulation.

5. Semantic memory is, roughly, memory for general factual information that does not include spatiotemporal details of the learning context. Your memory that Michelangelo painted the Sistine Chapel is semantic, (unless you remember this fact by reliving the experience in which you learned it).
6. Thanks to an anonymous reviewer for prompting this section.
7. On this reading of simulation theory, the present participles – remember*ing* and simulat*ing*—are merely used to convey that these event representations unfold over time.
8. Khalidi (2023, p. 128) argues in a similar vein that episodic memory is a distinct natural kind of *capacity*, and that episodic memor*ies* are a distinct natural kind of *state* produced by this capacity. I too will argue that episodic memories are a distinct natural kind of state, or rather *process*, since they unfold over time. Khalidi's arguments are different from mine since they rest on a view about the proper functions of the episodic memory capacity (see Robins, 2024 for discussion). The proper function of episodic memory is beyond the scope of this article (For discussion, see Boyle, 2019, 2022, 2024; Brown, 2024; De Brigard, 2014b; Mahr & Csibra, 2018; Schwartz, 2020).
9. The objective relations of similarity and difference that individuate natural kinds may obtain in virtue of whether *relational* properties are/are not, shared among relevant particulars or types. Kind-defining properties need not be intrinsic.
10. The points I make later could be reformulated using one of the other theories of natural kinds, e.g., *promiscuous realism* (Dupré, 1996), *pragmatic realism* (Boyle, 2024; Magnus, 2012), the *stable property cluster* account (Slater, 2015), etc.
11. For convenience, we'll assume that episodic simulation is a unified natural kind. But in reality, what gets called *episodic simulation* might comprise importantly different natural kinds of phenomena.
12. The brain areas active during episodic memory retrieval and episodic future simulation *do not fully overlap*. Episodic future simulation recruits more activation of frontal brain areas (Schacter & Addis, 2007). Thus, the neuroimaging evidence does *not* support the claim that episodic memory retrieval and episodic simulation involve *only* the same natural kinds (cf. Schwartz, 2020).
13. The core brain network includes the hippocampus, posterior cingulate cortex, inferior parietal lobe, medial prefrontal cortex, and lateral temporal cortex (De Brigard, 2014b, p. 174)
14. As the inference is inductive, "probably" should be read between the lines.
15. Throughout, "continuum" is used in the very loose sense of an ordering. "continuum" is *not* used in the restrictive sense of a scale any two positions on which are separated by infinitely many other positions. "Continua" in the loose sense need not be continuous measures. Only the loose sense can be used with confidence here. For it is unclear how one would begin to *quantify* the extents to which episodic representations causally or representationally depend on strong memory traces. This may be the makings of a further problem for simulation theorists and others who argue from transitional gradation (see the next section). But I cannot develop this theme here.
16. Moreover, as HPC kinds change over time, their defining properties and homeostatic mechanisms also change. This is an additional reason why HPC kinds' defining properties and mechanisms are not necessary conditions.
17. Thanks to an anonymous reviewer for pressing me on this.
18. The quotation marks around "degree" are meant to acknowledge the obscurity in what *exactly* the degrees might be degrees of.
19. Thanks to two anonymous reviewers for pressing me to discuss this argument.

20. The arguments from Andonovski (2020) and Aronowitz (2022) are also based on semanticization. This is a phenomenon whereby episodic memories of particular events gradually lose episode-specific details and become more general over the process of *systems consolidation*. More on this shortly. By *composition*, Gentry and Buckner refer to the fact that episodic memories include content drawn from semantic memory, for example, by including general knowledge (e.g., schemas and semantics). Gentry and Buckner also note that grid and place cell activity is involved in place-based navigation, episodic memory, and many other mental processes (see, e.g., Epstein et al., 2017).
21. This does not mean that it occurs at a constant speed (Dawkins, 2016, ch. 9).
22. Mutation rates vary by species. In humans, it is between 50–100 nucleotide mutations per generation, in a large genome of about 3.2 billion nucleotides (Antonarakis & Cooper, 2019).
23. *X*, *Y*, and *Z* are ring species just in case *x*s can interbreed (successfully) with *y*s, *y*s can interbreed with *z*s, but *x*s cannot interbreed with *z*s.
24. Of course, some view species not as kinds but as *individuals* (for the classic arguments, see Ghiselin, 1974; Hull, 1978). But Gentry and Buckner assume that species are kinds, and so the objection in the main text is dialectically appropriate. Moreover, it is hard to deny that there are *some* distinct kinds of evolved phenomena in biology. Extant kinds of organs, for example, are different to ancestral kinds of organs, but are separated via many transitional forms. Camera eyes, like we have, are different in kind to eyespots (thank heavens).
25. For example, in a randomized experiment, McElhiney and colleagues found that patients who received bilaterial ECT were significantly impaired recalling recent but not remote events compared against both control subjects and patients who had received only right unilateral ECT (McElhiney et al., 1995). (In ECT, direct current is transmitted between electrodes placed on the scalp. It is effective in treating depression, but TGRA can result.)
26. This section owes a debt to De Brigard (2020), who argues that memory traces exist and drive memory because they are an indispensable part of our best scientific theories of memory. I extend De Brigard's approach by showing that episodic memory is *a distinct natural kind* from episodic simulation.
27. Encoding is the stage of memory processing that takes place during and slightly after initial experience.
28. Depth of processing effects also show up in semantic memory performance. It is important not to confuse *semantic processing*, as this term figures in the depth of processing framework, with semantic memory.
29. Recognition tests present study-items together with foils. The subject is tasked with identifying the study-items. Crucially, there is no one-to-one correspondence between different types of memory tests and different kinds of memory. It would be a mistake to assume, for example, that recognition tests only measure semantic memory and recall tests only measure episodic memory. As Yonelinas et al. (2024) point out, "[r]ecognition memory is perhaps the simplest and most widely studied measure of episodic memory" (2024, p. 923). The prevailing view is that correct recognition judgments *can* be driven by semantic memory alone, as when the subject *knows* that an item was on the study list simply because it seems *familiar*. But recognition judgments can also be driven by episodic memory, as when the subject *remembers* encountering the item (see, e.g., Tulving, 1985; Yonelinas et al., 2024).
30. Not all of an occurrent memory's content is stored. Some is provided by the retrieval context.

Acknowledgements

Special thanks to Ali Boyle and two anonymous referees for this journal for comments on an earlier draft of this article. I also thank an audience at the 29th Meeting of the Philosophy of Science Association in New Orleans, LA for helpful questions and comments. Thanks especially to Jonathan Birch, David Colaço, and Armin Schulz.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

I thank UKRI for generous support through the Future Leaders grant to Ali Boyle, 'Episodic Memory: Uniquely Human?' no. MR/W00741X/1.

ORCID

Arieh Schwartz http://orcid.org/0000-0002-2777-1732

Data availability statement

There are no data associated with this article.

References

Addis, D. R. (2018). Are episodic memories special? On the sameness of remembered and imagined event simulation. *Journal of the Royal Society of New Zealand*, *48*(2–3), 64–88. https://doi.org/10.1080/03036758.2018.1439071

Andonovski, N. (2018). Is episodic memory a natural kind? *Essays in Philosophy*, *19*(2), 178–195. https://doi.org/10.7710/1526-0569.1609

Andonovski, N. (2020). Singularism about episodic memory. *Review of Philosophy and Psychology*, *11*(2), 335–365. https://doi.org/10.1007/s13164-020-00464-y

Antonarakis, S. E., & Cooper, D. N. (2019). 6 - human genomic variants and inherited disease: Molecular mechanisms and clinical consequences. In R. E. Pyeritz, B. R. Korf, & W. W. Grody (Eds.), *Emery and Rimoin's principles and practice of medical genetics and genomics* (7th ed. pp. 125–200). Academic Press. https://doi.org/10.1016/B978-0-12-812537-3.00006-8

Aronowitz, S. (2022). Semanticization challenges the episodic-semantic distinction. *British Journal for the Philosophy of Science*, 721760. https://doi.org/10.1086/721760

Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences*, *5*(12), 533–539. https://doi.org/10.1016/S1364-6613(00)01804-0

Bartlett, F. C. (1932). *Remembering: A study in experimental and social psychology*. Cambridge University Press.

Bernecker, S. (2012). *Memory: A philosophical study* (1. publ. in paperback ed.). Oxford University Press.

Boyd, R. (1991). Realism, anti-foundationalism and the enthusiasm for natural kinds. *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition*, *61*(1/2), 127–148. https://www.jstor.org/stable/4320174

Boyd, R. (1999). Kinds, complexity and multiple realization. *Philosophical Studies*, *95*(1), 67–98. https://doi.org/10.1023/A:1004511407133

Boyle, A. (2019). Learning from the past: Epistemic generativity and the function of episodic memory. *Journal of Consciousness Studies*, *26*(5–6), 242–251.

Boyle, A. (2022). The mnemonic functions of episodic memory. *Philosophical Psychology*, *35* (3), 327–349. https://doi.org/10.1080/09515089.2021.1980520

Boyle, A. (2024). Disagreement & classification in comparative cognitive science. *Noûs*, *58* (3), 825–847. https://doi.org/10.1111/nous.12480

Bremner, J. D., Vythilingam, M., Vermetten, E., Anderson, G., Newcomer, J. W., & Charney, D. S. (2004). Effects of glucocorticoids on declarative memory function in major depression. *Biological psychiatry*, *55*(8), 811–815. https://doi.org/10.1016/j.biopsych.2003.10.020

Brown, S. A. B. (2024). Episodic memory and unrestricted learning. *Philosophy of Science*, *91* (1), 90–110. https://doi.org/10.1017/psa.2023.16

Buckner, C. (2016). Transitional gradation in the mind: Rethinking psychological kindhood. *British Journal for the Philosophy of Science*, *67*(4), 1091–1115. https://doi.org/10.1093/bjps/axv020

Cheng, S., & Werning, M. (2016). What is episodic memory if it is a natural kind? *Synthese*, *193*(5), 1345–1385. https://doi.org/10.1007/s11229-014-0628-6

Corkin, S. (1984). Lasting consequences of bilateral medial temporal lobectomy: Clinical course and experimental findings in H. M. *Seminars in neurology*, *4*(2), 249–259. https://doi.org/10.1055/s-2008-1041556

Craik, F. I. M. (2002). Levels of processing: Past, present and future? *Memory (Hove, England)*, *10*(5–6), 305–318. https://doi.org/10.1080/09658210244000135

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*(6), 671–684. https://doi.org/10.1016/S0022-5371(72)80001-X

Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology General*, *104*(3), 268–294. https://doi.org/10.1037/0096-3445.104.3.268

Craver, C. F. (2020). Remembering: Epistemic and empirical. *Review of Philosophy and Psychology*, *11*(2), 261–281. https://doi.org/10.1007/s13164-020-00469-7

Cummins, R. (1996). *Representations, targets, and attitudes*. The MIT Press. https://doi.org/10.7551/mitpress/5887.001.0001

Dawkins, R. (2016). *The blind watchmaker: Why the evidence of evolution reveals a universe without design*. (Reissued). Penguin books.

De Brigard, F. (2014a). The nature of memory traces. *Philosophy Compass*, *9*(6), 402–414. https://doi.org/10.1111/phc3.12133

De Brigard, F. (2014b). Is memory for remembering? Recollection as a form of episodic hypothetical thinking. *Synthese*, *191*(2), 155–185. https://doi.org/10.1007/s11229-013-0247-7

De Brigard, F. (2020). The explanatory indispensability of memory traces. *The Harvard Review of Philosophy*, *27*, 23–47. https://doi.org/10.5840/harvardreview202072328

De de, A. J. O., & Smith, C. N. (2016). The functional and structural neuroanatomy of systems consolidation for autobiographical and semantic memory. In R. E. Clark & S. J. Martin (Eds.), *Behavioral neuroscience of learning and memory* (Vol. 37, pp. 119–150). Springer International Publishing. https://doi.org/10.1007/7854_2016_452

Drexler, S. M., & Wolf, O. T. (2018). Behavioral disruption of memory reconsolidation: From bench to bedside and back again. *Behavioral Neuroscience*, *132*(1), 13–22. https://doi.org/10.1037/bne0000231

Duncan, C. P. (1949). The retroactive effect of electroshock on learning. *Journal of Comparative and Physiological Psychology*, *42*(1), 32–44. https://doi.org/10.1037/h0058173

Dupré, J. (1996). *The disorder of things: Metaphysical foundations of the disunity of science* (1. paperback ed.). Harvard University Press.

Epstein, R. A., Patai, E. Z., Julian, J. B., & Spiers, H. J. (2017). The cognitive map in humans: Spatial navigation and beyond. *Nature Neuroscience*, *20*(11), 1504–1513. https://doi.org/10.1038/nn.4656

Flexner, J. B., Flexner, L. B., & Stellar, E. (1963). Memory in mice as affected by intracerebral puromycin. *Science*, *141*(3575), 57–59. https://www.jstor.org/stable/1710907

Fraser, L. M., O'Carroll, R. E., & Ebmeier, K. P. (2008). The effect of electroconvulsive therapy on autobiographical memory: A systematic review. *The Journal of ECT*, *24*(1), 10–17. https://doi.org/10.1097/YCT.0b013e3181616c26

Gentry, H., & Buckner, C. (2024). Transitional gradation and the distinction between episodic and semantic memory. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *379*(1913), 20230407. https://doi.org/10.1098/rstb.2023.0407

Ghiselin, M. T. (1974). A radical solution to the species problem. *Systematic Zoology*, *23*(4), 536–544. https://doi.org/10.2307/2412471

Gilboa, A., & Moscovitch, M. (2021). No consolidation without representation: Correspondence between neural and psychological representations in recent and remote memory. *Neuron*, *109*(14), 2239–2255. https://doi.org/10.1016/j.neuron.2021.04.025

Hassabis, D., & Maguire, E. A. (2007). Deconstructing episodic memory with construction. *Trends in Cognitive Sciences*, *11*(7), 299–306. https://doi.org/10.1016/j.tics.2007.05.001

Hawley, K., & Bird, A. (2011). What are natural kinds? Philosophical Perspectives, 25, 205–221. https://www.jstor.org/stable/41329468

Hull, D. L. (1978). A matter of individuality. *Philosophy of Science*, *45*(3), 335–360. https://doi.org/10.1086/288811

(2023). Episodic memory. In Khalidi, M. A. (Ed.), *Cognitive ontology: Taxonomic practices in the mind-brain sciences* (pp. 123–157). Cambridge University Press. https://doi.org/10.1017/9781009223645.006

Klinzing, J. G., Niethard, N., & Born, J. (2019). Mechanisms of systems memory consolidation during sleep. *Nature Neuroscience*, *22*(10), 1598–1610. https://doi.org/10.1038/s41593-019-0467-3

Koskinen, I. (2020). Defending a risk account of scientific objectivity. *British Journal for the Philosophy of Science*, *71*(4), 1187–1207. https://doi.org/10.1093/bjps/axy053

Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior*, *13*(5), 585–589. https://doi.org/10.1016/S0022-5371(74)80011-3

Loftus, E. F., & Pickrell, J. E. (1995). The formation of false memories. *Psychiatric Annals*, *25*(12), 720–725. https://doi.org/10.3928/0048-5713-19951201-07

Magnus, P. D. (2012). *Scientific enquiry and natural kinds*. Palgrave Macmillan UK.

Mahr, J., & Csibra, G. (2018). Why do we remember? The communicative function of episodic memory. *Behavioral and Brain Sciences*, *41*, 1–93. https://doi.org/10.1017/S0140525X17000012

Martin, C. B., & Deutscher, M. (1966). Remembering. *The Philosophical Review*, *75*(2), 161–196. https://doi.org/10.2307/2183082

McCarroll, C. J., Michaelian, K., & Nanay, B. (2022). Explanatory contextualism about episodic memory: Towards a diagnosis of the causalist-simulationist debate. *Erkenntnis*, *89*(6), 2273–2301. https://doi.org/10.1007/s10670-022-00629-4

McClelland, J. L., McNaughton, B. L., & Lampinen, A. K. (2020). Integration of new information in memory: New insights from a complementary learning systems perspective. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375* (1799), 20190637. https://doi.org/10.1098/rstb.2019.0637

McClelland, J. L., McNaughton, B. L., & O'Reilly, R. C. (1995). Why there are complementary learning systems in the hippocampus and neocortex: Insights from the successes and failures of connectionist models of learning and memory. *Psychological Review*, *102*(3), 419–457. https://doi.org/10.1037/0033-295X.102.3.419

McElhiney, M. C., Moody, B. B., Steif, B. L., Prudic, J., Devanand, D. P., Nobler, M. S., & Sackeim, H. A. (1995). Autobiographical memory and mood- effects of electroconvulsive therapy -. *Neuropsychology*, *9*(4), 501–517. https://doi.org/10.1037/0894-4105.9.4.501

McGaugh, J. L. (2015). Consolidating memories. *Annual Review of Psychology*, *66*(1), 1–24. https://doi.org/10.1146/annurev-psych-010814-014954

McGaugh, J. L., & Krivanek, J. A. (1970). Strychnine effects on discrimination learning in mice: Effects of dose and time of administration. *Physiology & Behavior*, *5*(12), 1437–1442. https://doi.org/10.1016/0031-9384(70)90133-2

Michaelian, K. (2015). Opening the doors of memory: Is declarative memory a natural kind? *WIREs Cognitive Science*, *6*(6), 475–482. https://doi.org/10.1002/wcs.1364

Michaelian, K. (2016a). *Mental time travel: Episodic memory and our knowledge of the personal past*. MIT Press.

Michaelian, K. (2016b). Against discontinuism: Mental time travel and our knowledge of past and future events. In Michaelian, K., Klein, S.B., Szpunar, K.K.(Eds.), *Seeing the future: Theoretical perspectives on future-oriented mental time travel* (pp. 62–92). Oxford University Press.

Michaelian, K. (2022). Radicalizing simulationism: Remembering as imagining the (non-personal) past. *Philosophical Psychology*, *37*(5), 1–27. https://doi.org/10.1080/09515089.2022.2082934

Moscovitch, M., & Gilboa, A. (2024). Systems consolidation, transformation, and reorganization: Multiple trace theory, trace transformation theory, and their competitors. In M. J. Kahana & A. D. Wagner (Eds.), *The Oxford handbook of human memory, two volume pack* (1st ed. pp. 1278–1328). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190917982.013.43

Nadel, L., & Moscovitch, M. (1997). Memory consolidation, retrograde amnesia and the hippocampal complex. *Current Opinion in Neurobiology*, *7*(2), 217–227. https://doi.org/10.1016/S0959-4388(97)80010-4

Nadel, L., Samsonovich, A., Ryan, L., & Moscovitch, M. (2000). Multiple trace theory of human memory: Computational, neuroimaging, and neuropsychological results. *Hippocampus*, *10*(4), 352–368. https://doi.org/10.1002/1098-1063(2000)10:4<352::AID-HIPO2>3.0.CO;2-D

Nader, K., Schafe, G. E., & Le Doux, J. E. (2000). Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. *Nature*, *406*(6797), 722–726. https://doi.org/10.1038/35021052

Okuda, J., Fujii, T., Oxhtake, H., Tsukiura, T., Tanji, K., Suzuki, K., Kawashima, R., Fukuda, H., Itoh, M., & Yamadori, A. (2003). Thinking of the future and past: The roles of the frontal pole and the medial temporal lobes. *Neuroimage*, *19*(4), 1369–1380. https://doi.org/10.1016/S1053-8119(03)00179-4

Perrin, D. (2018). A case for procedural causality in episodic recollection. In K. Michaelian, D. Debus, & D. Perrin (Eds.), *New directions in the philosophy of memory* (pp. 33–51). Routledge, Taylor & Francis Group.

Robins, S. K. (2016). Misremembering. *Philosophical Psychology*, *29*(3), 432–447. https://doi.org/10.1080/09515089.2015.1113245

Robins, S. K. (2024). Kinding memory: Commentary on Muhammad Ali Khalidi's *cognitive ontology*. *Mind & Language*, *39*(1), 109–115. https://doi.org/10.1111/mila.12477

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory & Cognition*, *21*(4), 803–814. https://doi.org/10.1037//0278-7393.21.4.803

Schacter, D. L. (2021). *The seven sins of memory: How the mind forgets and remembers* (Updated ed.). Mariner Books; Houghton Mifflin Harcourt.

Schacter, D. L., & Addis, D. R. (2007). On the constructive episodic simulation of past and future events. *Behavioral and Brain Sciences*, *30*(3), 331–332. https://doi.org/10.1017/S0140525X07002178

Schulz, A., & Robins, S. (2023). Episodic memory, simulated future planning, and their evolution. *Review of Philosophy and Psychology*, *14*(3), 811–832. https://doi.org/10.1007/s13164-021-00601-1

Schwartz, A. (2020). Simulationism and the function(s) of episodic memory. *Review of Philosophy and Psychology*, *11*(2), 487–505. https://doi.org/10.1007/s13164-020-00461-1

Sekeres, M. J., Winocur, G., & Moscovitch, M. (2018). The hippocampus and related neocortical structures in memory transformation. *Neuroscience Letters*, *680*, 39–53. https://doi.org/10.1016/j.neulet.2018.05.006

Slater, M. H. (2015). Natural kindness. *British Journal for the Philosophy of Science*, *66*(2), 375–411. https://doi.org/10.1093/bjps/axt033

Squire, L. R. (2009). The legacy of patient h. M. for neuroscience. *Neuron*, *61*(1), 6–9. https://doi.org/10.1016/j.neuron.2008.12.023

Squire, L. R., Genzel, L., Wixted, J. T., & Morris, R. G. (2015). Memory consolidation. *Cold Spring Harbor Perspectives in Biology*, *7*(8), a021766. https://doi.org/10.1101/cshperspect.a021766

Squire, L. R., Slater, P. C., & Chace, P. M. (1975). Retrograde amnesia: Temporal gradient in very long term memory following electroconvulsive therapy. *Science (New York, NY)*, *187*(4171), 77–79. https://doi.org/10.1126/science.1109228

Sterelny, K. (2001). *Dawkins vs. Gould: Survival of the fittest*. Icon Books [u.a.].

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*(3), 299–313. https://doi.org/10.1017/S0140525X07001975

Szpunar, K. K., Watson, J. M., & McDermott, K. B. (2007). Neural substrates of envisioning the future. *Proceedings of the National Academy of Sciences*, *104*(2), 642–647. https://doi.org/10.1073/pnas.0610082104

Tahko, T. E. (2022). Natural kinds, mind-independence, and unification principles. Synthese, 200(2), 144. https://doi.org/10.1007/s11229-022-03661-7

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology / Psychologie canadienne*, *26*(1), 1–12.

Winocur, G., & Moscovitch, M. (2011). Memory transformation and systems consolidation. Journal of the International Neuropsychological Society, 17(05), 766–780. https://doi.org/10.1017/S1355617711000683

Yonelinas, A. P., Ramey, M. M., & Riddell, C. (2024). Recognition memory: The role of recollection and familiarity. In M. J. Kahana & A. D. Wagner (Eds.), *The Oxford handbook of human memory, two volume pack* (1st ed. pp. 923–958). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190917982.013.32