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Is Episodic Memory a Natural Kind? A Comment on Cheng and Werning's "What Is Episodic Memory If It Is a Natural Kind?" (2016)

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Abstract

In a recent paper, Sen Cheng and Markus Werning argue that the class of episodic memories constitutes a natural kind. Endorsing the homeostatic property cluster view of natural kinds, they suggest that episodic memories can be characterized by a cluster of properties unified by an underlying neural mechanism for coding sequences of events. Here, I argue that Cheng and Werning's proposal faces some significant, and potentially insurmountable, difficulties. Two are described as most prominent. First, the proposal fails to satisfy an important normative constraint on natural kind theorizing, not providing the requisite theoretical resources for arbitration between rival taxonomies of memory. Second, the proposal is in direct tension with a foundational principle of the HPC view: the rejection of essentialism. This has far-reaching consequences, which threaten to undermine the coherence of the proposal.

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Introduction

Is episodic memory a natural kind? Despite some impressive developments in the study of memory,¹ this issue has received little philosophical attention.² In a recent paper, Sen Cheng and Markus Werning set out to fill this gap.³ Putting forward a bold and innovative proposal, Cheng and Werning weave evidence from philosophy, psychology, and neuroscience to support an affirmative answer to the titular question. They anchor the proposal on Richard Boyd's homeostatic property cluster (HPC) view of natural kinds.⁴ On this view, natural kinds are classes of entities that are likely to share relevant properties because of an underlying causal mechanism. Episodic memories, Cheng and Werning argue, comprise such a class. They are knowledge-like states characterized by mnemonic representations of personally experienced episodes, which afford subsequent simulation. The key feature of these representations is sequentiality, which is the distinguishing characteristic of both their content and their underlying neural realization. Crucially, the properties' episodic memories share are clustered together in virtue of a neural mechanism for coding sequences of events (grouped in episodes). Episodic memory, consequently, should be considered a natural kind.⁵ In this brief discussion, I argue that Cheng and Werning's proposal faces some significant, and potentially insurmount-

¹ For an overview of recent developments in the philosophy of memory, see Sven Bernecker and Kourken Michaelian, eds., *The Routledge Handbook of Philosophy of Memory* (London: Routledge, 2017) and Kourken Michaelian, Dorothea Debus, and Denis Perrin, eds., *New Directions in the Philosophy of Memory* (New York: Routledge, 2018). For recent developments in the psychology and neuroscience of memory, see Daniel L. Schacter, et al., "The Future of Memory: Remembering, Imagining, and the Brain," *Neuron* 76, no. 4 (2012): 677–94; and Scott D. Slotnick, *Cambridge Neuroscience of Memory* (Cambridge, UK: Cambridge University Press, 2017).

² It is perhaps not unfair to say that there is no other recent article that directly investigates whether *episodic* memory is a natural kind. Kourken Michaelian investigates the related question "is memory a natural kind?" providing a negative answer. See Michaelian, "Is Memory a Natural Kind?" *Memory Studies* 4, no. 2 (2010): 170–89; and *Mental Time Travel: Episodic Memory and Our Knowledge of the Personal Past* (Cambridge, MA: MIT Press).

³ Sen Cheng and Markus Werning, "What Is Episodic Memory If It Is a Natural Kind?" *Synthese* 193, no. 5 (2016): 1345–85.

⁴ See Richard Boyd, "Realism, Anti-foundationalism, and the Enthusiasm for Natural Kinds," *Philosophical Studies* 61, no. 1 (1991): 140–43; and "Kinds, Complexity and Multiple Realization," *Philosophical Studies* 95 (1999): 67–98.

⁵ More specifically, Cheng and Werning express "optimism that episodic memory . . . is likely to be a natural kind" ("What Is Episodic Memory," 1346). This may be interpreted as an important qualification of the major claim, but I doubt that this is the interpretation the authors favor. In any circumstance, here I investigate the reasons for Cheng and Werning's optimism.

able, difficulties. After summarizing the authors' case in section 2, I argue in section 3 that the proposal fails to satisfy an important normative constraint on natural kind theorizing. Namely, the authors don't provide the requisite theoretical resources for settling disputes between rival taxonomies of memory. In section 4, I point to another important problem, arguing that Cheng and Werning's approach is in direct tension with a foundational principle of the HPC view: the rejection of essentialism. This has far-reaching consequences that threaten to undermine the coherence of the proposal.

Episodic Memory as a Natural Kind

Cheng and Werning endorse Boyd's *homeostatic property cluster* (HPC) view of natural kinds. On the HPC view, natural kinds are classes of entities that tend to share relevant properties by virtue of an underlying causal mechanism. Let's introduce the major components of the view by looking at Boyd's classic case for biological species as natural kinds. First, a natural kind is a class of entities that tend to have certain properties in common. Thus, members of the same species share important morphological, behavioral, and physiological features. Second, the regular co-occurrence of these properties in conspecifics is not an accident. There is a causal mechanism that explains their clustering (namely: interbreeding).⁶ Boyd calls such mechanisms "homeostatic." Third, the property cluster must figure in relevant causal generalizations. This is designed to exclude clusters and mechanisms that are of little theoretical value. Finally, the class of entities must be *maximal* with regard to its explanatory potential. This means that no superset of the class should be able to provide the same explanatory leverage. Sticking with our example, the generalizations available for the class *lions* will not be available for the class *lions and flying squirrels*. In sum, a class C of entities is a natural kind if and only if there is a cluster of properties that (1) regularly co-occur (2) because of an underlying homeostatic mechanism, and (3) figure in relevant causal generalizations, such that (4) C is the maximal class whose members are likely to share these properties in virtue of the underlying mechanism.⁷ With this in mind, let's turn to Cheng and Werning's treatment of episodic memory. To make the case that episodic memory is an HPC kind, they

⁶ On the so-called ontic approach to explanation, what performs the explanation is an objective feature of the world (the mechanism), not a description of it. For details about the ontic approach, see Wesley C. Salmon, "Four decades of Scientific Explanation," in *Scientific Explanation* (Minnesota Studies in the Philosophy of Science), vol. 18 (Minneapolis: University of Minnesota Press, 1989) and Carl F. Craver, "The Ontic Account of Scientific Explanation," in *Explanation in the Special Sciences: The Case of Biology and History*, ed. Marie I. Kaiser et al. (Dordrecht: Springer Netherlands, 2014), 27–52.

⁷ See Cheng and Werning, "What Is Episodic Memory," 1358. Edouard Machery defines the notion of natural kind in an importantly similar way; see "Concepts Are Not a Natural Kind," *Philosophy of Science* 72, no. 3 (2005): 444–67.

have to demonstrate that the class of episodic memories is explanatorily maximal with regard to a relevant cluster of properties and a unifying homeostatic mechanism. This is precisely what they are out to deliver. Episodic memories, they argue, are characterized by representations of personally experienced episodes, which afford subsequent simulation. Unlike semantic memories, they represent *particular* episodes from the subjects' personal past.⁸ This is, of course, a familiar idea from the literature. The development of the idea, however, has been beset by much confusion, not the least of which pertains to the definition of an episode. Cheng and Werning are admirably clear in approaching this issue. They define an episode (E) as an ordered list of events (e_s), where the principle of ordering is temporal succession. For instance, the episode [Elena goes to a party] is a sequence of events [Elena leaves the house] < [Elena meets with her friend] < [Elena takes a cab] < [Elena enters the club], where " $e_1 < e_2$ " signifies that the event e_1 occurred *before* the event e_2 .⁹ The events that make up episodes are spatially and temporally extended particulars. Each event—as well as each episode, since an episode is a complex event—occupies a distinct region of space-time.¹⁰

With the definition in hand, Cheng and Werning are ready to present the property cluster that characterizes episodic memories. They do so in the form of a conceptual analysis, which they call "the Sequence Analysis of Episodic Memories." Given that the details are of some relevance, the analysis is worth presenting in full:

A subject S has episodic memory with content E at a time t_1 if and only if the following conditions are fulfilled:

- (S1) E is an episode with $E = \langle e_1, \dots, e_n \rangle$. E is called the *mnemonic content*.
- (S2) At some time t_1 , S compositionally represents E as an episode of temporally succeeding events e_1, \dots, e_n . S's representation of E at t_1 is called the *mnemonic representation*.
- (S3) At a time $t_0 < t_1$, S has a reliable experience of the temporally succeeding events e_1^*, \dots, e_m^* , which make up an episode $E^* = \langle e_1^*, \dots, e_m^* \rangle$. E^* is

⁸ This is a necessary, but not a sufficient condition. See Cheng and Werning's Sequence Analysis below for details.

⁹ Note that this is the only criterion the authors include. According to this definition, the sequence < [I fell down the stairs in 1987]...[I had lunch last night] > constitutes an episode. The definition is minimal, and accordingly liberal, by design. For details, see Cheng and Werning, "What Is Episodic Memory," 1351–52.

¹⁰ This has some important consequences. For details, see Cheng and Werning, "What Is Episodic Memory," 1353.

called the *experiential base*.

- (S4) The episode E^* occurs at or before t_0 (factivity).
- (S5) The mnemonic content E is *ontologically grounded* in the experiential base E^* in the following sense of counterfactual dependence: Were E^* to occur at or before t_0 , E would also occur at that time.
- (S6) S 's representation with content E at t_1 is *causally grounded* in S 's experience of E^* through a reliable memory trace.
- (S7) On the basis of its mnemonic representation with content E , S is capable of generating a temporally explicit simulation with content E at some time $t_2 \geq t_1$. The generated simulation is called a *mnemonic simulation*. (2016, 1354)

As the authors are quick to note, the conditions (S1–S7) relate to the four major stages of memory processing: perception (S3, S4), encoding (S1), storage (S1, S2), and retrieval (S7). On the Sequence Analysis (SA), episodes, *qua* sequences of particular events, are the potential contents of mnemonic representations. Importantly, sequentiality is a key feature not only of the contents of episodic memories, but also of some vehicles. As condition S7 specifies, the subject must be capable of generating a mnemonic *simulation* based on the memory content. In a mnemonic simulation, the temporal succession of events in the represented episode is itself represented by a temporal succession of representational vehicles (read: neural processes).¹¹

Having specified the relevant property cluster, Cheng and Werning move to the next task: identifying the mechanism that maintains the homeostatic unity of episodic memories.¹² After arguing that the hippocampus is the “principal anatomical substrate” of episodic memory,¹³ they describe the putative hippocampal mechanism responsible for the

¹¹ See below for details.

¹² Actually, Cheng and Werning first discuss the explanatory maximality and minimality of the property cluster. For expository purposes, I have changed the order of presentation here. See section 4 for why this may have been necessary.

¹³ Support for this claim comes from data suggesting that hippocampal activity is necessary for encoding, storage *and* retrieval of episodic memories as well as from lack of evidence pertaining to the critical role of other brain regions (“What Is Episodic Memory,” 1364–71). Cheng and Werning argue that the hippocampus is part of a “cortico-hippocampal” network that performs important episodic memory functions. The hippocampus, however, plays a *unique* role in episodic memory, “endowing” the network

clustering. I can only present the briefest of sketches here, but the basic idea should be relatively easy to understand. Building on evidence from the neurosciences, the authors propose that populations of hippocampal cells firing in temporal sequence may represent the sequences of events within individual episodes (S1, S2). While episodes typically unfold over seconds, a compression mechanism known as “theta phase precession”¹⁴ affords the generation of such representations at the timescale required for synaptic plasticity. The processes involved in the storage of sequences may thus provide a uniform causal mechanism for the grounding of memory representations in experiences (S3–S5). Moreover, there is evidence that in offline states, the relevant populations of neurons fire in sequences that correlate with the sequences in which they were active at the time of encoding. This neural replay may form the basis of temporally explicit simulations of previously experienced episodes (S6, S7).¹⁵

Finally, Cheng and Werning need to establish that the class of episodic memories is *maximal* with regard to its inductive and explanatory potential. They take this to require showing that *other* kinds of memory do not satisfy the conditions specified in the Sequence Analysis.¹⁶ Accordingly, they go on to argue that the conditions are jointly sufficient to distinguish episodic from procedural and semantic memories.¹⁷ This affords them a relatively swift conclusion: since “no other memory or cognitive process” satisfies conditions S1–S7,¹⁸ it follows that the class individuated by the analysis is explanatory maximal. But they don’t stop here. Expanding the discussion, they aim to show that the

with a specific computational capability (for details, see 1370–71).

¹⁴ See John O’Keefe and Michael Recce, “Phase Relationship between Hippocampal Place Units and the EEG Theta Rhythm,” *Hippocampus* 3, no. 3 (1993): 317–30; and William E. Skaggs, et al., “Theta Phase Precession in Hippocampal Neuronal Populations and the Compression of Temporal Sequences,” *Hippocampus* 6, no. 2 (1996): 149–72.

¹⁵ Cheng and Werning, “What Is Episodic Memory,” 1371–74.

¹⁶ See section 4 on why this is a bad interpretation of the maximality condition.

¹⁷ Thus, procedural memories don’t have contents representable as sequences of events (S1), and they are not grounded in experiences of particular episodes (S5, S6). The focus of the discussion, however, is on the relationship between episodic and *semantic* memory. While conceding that “future work . . . is needed” (1364) to fully elucidate this relationship, the authors are confident that the Sequence Analysis provides a good starting point. If we accept their argumentative approach, there may be a strong case for this claim. After all, mirroring the argument above, most semantic memories neither represent (S1) nor are grounded in (S5, S6) *particular* episodes.

¹⁸ Notice that the relationship to *other* cognitive processes is not investigated. This matters in the context of the neoempiricist revival associated with “mental time travel” literature.

class is also *minimal*,¹⁹ which they interpret as implying that all of the conditions in the analysis are necessary. Accordingly, they go on to catalog the different ways in which violation of the conditions leads to deficiencies in episodic memory.²⁰ For instance, the purported memory representation may be false, improperly grounded in a previous experience or it may not afford a temporally explicit simulation of the relevant episode. That all of these cases constitute deficiencies of episodic memory, the argument goes, demonstrates that the class of episodic memories is also minimal with regard to its inductive and explanatory potential.

This completes Cheng and Werning’s case. In sum, episodic memories exhibit properties that (1) regularly co-occur (2) because of a homeostatic neural mechanism. These properties (3) figure in important causal generalizations, and (4) the class of episodic memories is the maximal class of entities for which such generalizations are available. Admittedly, this is a very brief sketch of the account. But, there is enough here to anchor our discussion.

Episodic Memory: Tracking and Arbitration

The HPC view imposes different normative constraints on theorizing about natural kinds. Two are of central importance for our purposes; let’s call them *tracking* and *arbitration*. According to the tracking condition, the kinds recognized by scientific taxonomies must track relevant homeostatic mechanisms.²¹ On the HPC view, taxonomies are adequate only to the extent that they satisfy this condition.²² The arbitration condition is equally important. Since the appeal to mechanisms is meant to secure an *objective* foundation for taxonomies of kinds—that is, to tell us where the natural “joints” really are—the mechanistic structure of the world must be able to arbitrate between competing taxonomies.²³ To keep with our example above, a great number of candidate taxonomies of species are discarded as inadequate by an appeal to the underlying mechanism of

¹⁹ Tellingly, Cheng and Werning don’t mention explanatory *minimality* when they introduce the criteria for HPC kinds. See section 4 for why minimality, properly understood, is not a relevant criterion.

²⁰ Cheng and Werning, “What Is Episodic Memory,” 1359–63.

²¹ As such, homeostatic mechanisms seem to play the role essences play in traditional, essentialist accounts. For a defense of this claim, see Paul E. Griffiths, “Squaring the Circle: Natural Kinds with Historical Essences.” In *Species: New Interdisciplinary Essays*, ed. Robert A. Wilson (Cambridge, MA: MIT Press, 1999).

²² As Craver puts it, on the HPC view, “nature’s joints are located at the boundaries of mechanisms” (“Mechanisms and Natural Kinds,” *Philosophical Psychology* 22, no. 5 (2009): 575.

²³ See Craver, “Mechanisms and Natural Kinds,” for a detailed analysis of this constraint.

interbreeding. Tracking and arbitration are closely linked: scientific taxonomies appeal to mechanisms that explain the co-occurrence of properties in members of proposed kinds, where such explanations license the acceptance of *these*, and not other kinds (put forward by rival taxonomies), as natural. If episodic memory is to be a natural kind, then (a) there must be a homeostatic mechanism that episodic memory tracks, and (b) appeals to this mechanism should allow us to arbitrate between rival taxonomies (of memory).

Does Cheng and Werning's proposal satisfy both conditions? As should be obvious from the exposition, they consider the provision of a tracking account as their main explanatory burden. Accordingly, they describe a mechanism purported to explain the clustering of properties delineated by the Sequence Analysis. The proposal is undoubtedly speculative, but it is also refreshingly rich in empirical detail. So assume for now that the tracking condition is satisfied.²⁴ What about arbitration? Here things are a bit more complicated. The first red flag comes from the way Cheng and Werning approach the validation of episodic memory as a natural kind. While the Sequence Analysis is supposed to be driven by experimental results from psychology and neuroscience,²⁵ the property cluster is presented via analysis of the *concept* of episodic memory. Importantly, there is no appeal to mechanisms—homeostatic or otherwise—in the argument(s) for the necessity of conditions S1–S7. The argumentative strategy is essentially of the divide-and-conquer variety: *first* a philosophical analysis to specify the co-instantiating properties, *then* neuroscientific evidence for the existence of a relevant homeostatic mechanism.²⁶ The consequences are significant. Since the authors don't provide additional constraints on

²⁴ Whether this is the case is very much an empirical question. In this comment, I focus only on the large-scale *methodological* issues pertaining to Cheng and Werning's proposal. While there is much to be said about the empirical component of the proposal, I reserve that for a future occasion.

²⁵ Cheng and Werning, "What Is Episodic Memory," 1345.

²⁶ This is not a straw man. Cheng and Werning use the phrase "philosophical analysis" repeatedly, emphasizing that they are analyzing the *concept* of episodic memory ("What Is Episodic Memory," 1353). Indeed, they list desiderata for the conceptual analysis. While one of the desiderata (D4) stipulates that the analysis should be "in accordance with our knowledge of neural mechanisms that underlie episodic memory" (1352), this is not reflected in the *kinds* of arguments Cheng and Werning provide for the necessity of conditions S1–S7. For example, the argument for the inclusion of the controversial condition S6 (the memory trace condition), as short as it is, does not involve a reference to a homeostatic mechanism. Rather it presents considerations of the traditional philosophical sort, even passing the buck back to C. B. Martin and Max Deutscher's classic treatment ("Remembering," *Philosophical Review* 75, no. 2 [1966]: 161–96). The situation is similar with the other conditions. Given this, the characterization of the Sequence Analysis as "philosophical" is unlikely to be only a consequence of the authors' exposition strategy.

the kinds of mechanisms that should be considered,²⁷ there may be *competing* analyses (of the relevant psychological) kinds that satisfy the tracking condition.

Consider the recent debate between simulationists and causal theorists of memory. Regarding simulation theories, episodic remembering is seen as a process of simulating past events where a causal connection to the remembered event is *not* necessary.²⁸ Moreover, most simulationists consider the difference between episodic memory and episodic *future* thought—that is, the simulation of future episodes—to be a difference of degree and not of kind.²⁹ Accordingly, simulationist analyses³⁰ of the relevant kinds will tend to focus on properties clustered in virtue of mechanisms operative in different forms of episodic thought. Such analyses will typically drop the memory trace condition (S6) as well as conditions S4 and S6, grounding episodic representations in *past* experiences.³¹ Now, let's assume we stick with the emphasis on sequences³² and consider only the property cluster S1–S3 and S7. Let's call this the Simulationist Sequence Analysis (SSA).

Is there a neural mechanism that explains the regular co-occurrence of these properties?³³

²⁷ On the so-called “consensus view” of mechanisms in recent philosophy of science, see Carl F. Craver and James Tabery, “Mechanisms in Science,” in *The Stanford Encyclopedia of Philosophy* (Spring 2017 edition), edited by Edward N. Zalta, <https://plato.stanford.edu/archives/spr2017/entries/science-mechanisms/>. “Mechanist” philosophers have generally opted for a *minimal* characterization of mechanisms, describing them as sets of entities and activities organized in particular ways (e.g., causal, spatial, temporal) to produce specific phenomena. Given this minimal approach, isolating clusters of properties that track homeostatic mechanisms will not be particularly difficult. See below.

²⁸ See Michaelian, *Mental Time Travel*; and Michaelian and John Sutton, “Memory,” in *The Stanford Encyclopedia of Philosophy* (Summer 2017 edition), ed. Edward N. Zalta, <https://plato.stanford.edu/archives/sum2017/entries/memory/>.

²⁹ In the terminology of Denis Perrin (2016), they are “continuists”; see Perrin, “Asymmetries in Subjective Time,” in *Seeing the Future: Theoretical Perspectives on Future-Oriented Mental Time Travel*, ed. Kourken Michaelian, et al. (New York: Oxford University Press, 2016), 39–61. Continuists may also hold that episodic *counterfactual* thought is not different in kind from episodic remembering.

³⁰ See Michaelian (*Mental Time Travel*, ch. 6) for an example of a simulationist analysis of episodic memory.

³¹ Notice: here the goal is to isolate a property cluster characterizing a class of entities likely to constitute a natural kind. The cluster does *not* characterize episodic memory specifically. Accordingly, the temporal markers in conditions S3 and S7 will also be eliminated. This allows a continuist treatment of (say) episodic memory and episodic future thought.

³² This is *not* an unproblematic assumption.

³³ More specifically: is there a mechanism that explains the occurrence of these *and only these* properties? See below (as well as section 4).

The answer is surely yes. Indeed, Cheng's (2013) very own CRISP theory of hippocampal function seems to describe such a mechanism. In CRISP, sequences of external stimuli are represented by sequences of neural activity in hippocampal area CA3. Importantly, unlike in rival theories, the input sequences are not stored in the hippocampus; rather, they are mapped onto *intrinsic* neural sequences in CA3.³⁴ As Cheng emphasizes, this is a crucial feature of CRISP: it allows the theory to account for both replay of past sensory sequences *and* pre-play of future sensory sequences in offline neural activity.³⁵ In essence, the underlying mechanism makes possible the representation (and simulation) of past *and* future episodes.³⁶ Described in such a way, the core hippocampal mechanism is one for coding sensory sequences, regardless of whether those are of past or future events. Thus, properties S1–S3 and S7 are regularly coinstantiated in virtue of a homeostatic mechanism, but there is no feature of the mechanism that necessitates the inclusion of further properties. Quite to the contrary, the class of entities picked out by the simulationist analysis is *maximal* with regard to its explanatory potential. If we include further properties—say: memory traces (S6)—we will sacrifice some important generalizations pertaining to the representation of sensory sequences *tout court*.³⁷ Now, importantly, the rival analyses—SA and SSA—license different and incompatible answers to our main question: is episodic memory a natural kind? On Cheng and Werning's SA, as we have seen, the answer is affirmative: episodic memory is split from other cognitive kinds. On the SSA, the answer is negative: episodic memory is lumped together with episodic future thought.³⁸ Both analyses, however, satisfy the tracking condition,

³⁴ For details, see Sen Cheng, "The CRISP Theory of Hippocampal Function in Episodic Memory," *Frontiers in Neural Circuits* 7, no. 88 (2013): 5–10.

³⁵ This is noted as a particular strength of the CRISP model. See Cheng, "CRISP Theory," 8–10.

³⁶ Note: this follows (only) on the minimalist view Cheng and Werning endorse. Since they build their case for a homeostatic mechanism on similar kinds of evidence, the tentative conclusion is satisfactory for our purposes.

³⁷ Note: the point here is *not* that memory traces don't exist. Indeed, there are good reasons—conceptual (Robins 2016) and empirical (Josselyn et al. 2015)—to think that they do (for conceptual reasons, see Sarah Robins, "Representing the Past: Memory Traces and the Causal Theory of Memory," *Philosophical Studies* 173 [2016]: 2993–3013; for empirical reasons, see Sheena A. Josselyn, Stefan Köhler, and Paul W. Frankland, "Finding the Engram," *Nature Reviews Neuroscience* 16 [2015]: 521–34). The point is that there is nothing in the pinpointed *mechanisms* that necessitates the inclusion of memory traces (the hippocampal representations may play the role of traces, but they do so only in specific circumstances).

³⁸ Cheng and Werning may insist that episodic memory is still a natural kind, despite being a *sub*-kind of episodic thought. This may be the case, but the more general point holds: the description of this class of neural mechanisms does not *necessitate* the inclusion of further properties in the cluster. At the very least, then, there is an inevitable *indeterminacy* in the characterization of the kinds (see section 4 for

pinpointing mechanisms that maintain the homeostatic unity of the purported kinds. So, which taxonomy should we choose? Are there reasons to privilege one (description of a) homeostatic mechanism? What kinds of reasons are these? Cheng and Werning, unfortunately, don't discuss these issues in any detail. Without satisfying answers, however, a simple appeal to mechanisms will not allow us to settle disputes between the rival taxonomies.

This is only the tip of the iceberg. As Craver (2009) has pointed out, *most* (cognitive) phenomena can be described as clusters of co-occurring properties supported by causal mechanisms. These mechanisms will operate at different levels of organization and will participate in a variety of causal-mechanistic explanations. Absent further constraints on the kinds of mechanisms that should be considered, one would find homeostatic property clusters wherever one finds systematic correlations.³⁹ And, given the array of explanatory purposes and projects, many of these will figure in important causal generalizations. This is particularly damning in the context of episodic memory, where proposed clusters are a dime a dozen. Not even leaving the letter *A*, we find proposals about the centrality of auto-noetic consciousness,⁴⁰ the importance of attribution⁴¹ in the experience of remembering, and the crucial role autobiographical⁴² knowledge plays in episodic memory. Most of these proposals are accompanied by taxonomies that satisfy the

further treatment of this important issue). Moreover, there are *many* competing taxonomies that provide incompatible verdicts on our main question (see below).

³⁹ This is a direct consequence of the *minimalist* conception of mechanisms sketched above. If any set of entities and activities, organized *somehow* to 'produce' a phenomenon, counts as a mechanism, then there will be *many* different property clusters that track homeostatic mechanisms. Moreover, a given cluster will be maintained by a number of such mechanisms. In Craver's example, the generation of an action potential can be described as a cluster of co-occurring properties that are homeostatically maintained by a variety of mechanisms: genetic (regulatory), proximal (input from presynaptic cells), developmental, and distal evolutionary ones. This problem generalizes ("Mechanisms of Natural Kinds," 582–83). Consequently, absent *some* further constraints on the kinds of mechanisms that should be considered, it will be relatively easy to satisfy the tracking condition.

⁴⁰ See Endel Tulving, "Memory and Consciousness," *Canadian Psychology* 26, no. 1 (1985): 1–26; and Stanley B. Klein, "What Memory Is," *WIREs Cognitive Science* 6, no. 1 (2015): 1–38.

⁴¹ See Larry L. Jacoby, Colleen M. Kelly, and June Dwyan, "Memory Attributions," in *Varieties of Memory and Consciousness: Essays in Honour of Endel Tulving*, edited by Henry L. Roediger and Fergus I. M. Craik (London: Lawrence Erlbaum, 1989), 391–422; and Marcia K. Johnson, Shanin Hashtroudi, and D. Stephen Lindsay, "Source Monitoring," *Psychological Bulletin* 114, no. 1 (1993): 3–28.

⁴² See Martin A. Conway, "Memory and the Self," *Journal of Memory and Language* 53, no. 4 (2005): 594–628.

tracking condition,⁴³ pinpointing mechanisms responsible for maintaining the specified property clusters. Yet, they issue incompatible verdicts on Cheng and Werning's titular question: "*what is episodic memory if it is a natural kind?*" These are cases of tracking without arbitration.

If mechanisms should help us arbitrate between rival proposals—providing an objective foundation for a taxonomy of kinds—then the privileging of specific mechanisms as relevant for episodic memory needs to be independently justified. For reasons only sketched in the previous paragraph, however, it is not clear how/where such independent justification can be acquired.⁴⁴ Consequently, Cheng and Werning opt for the easier route: they settle on an analysis of episodic memory in accordance with the available knowledge,⁴⁵ and then they provide evidence that the tracking condition has been satisfied. This strategy comes dangerously close to inverting the required direction of explanation. Given that the arbitration condition is not fulfilled, it is not the presence of an underlying mechanism that tells us where the natural "joint" of episodic memory is. Rather, the "joint" is located via a traditional conceptual analysis, which is then supported by an appeal to a specific class of neural mechanisms.⁴⁶ As a result, the putative unity of the proposed property cluster is as much *conceptual* as it is causal.

Maximality, Minimality and Empiricist Holdovers

The issues raised in the previous section point to a deeper problem with Cheng and Werning's proposal. Let's explore it by zooming in on some of the details of the HPC view. Importantly, Boyd advanced the view as an alternative to essentialism about natural kinds. Essentialists hold that natural kinds are characterized by the possession of a set of properties which all and only members of the kind share: the kind's *essence*. As Cheng

⁴³ This claim, admittedly, issues a promissory note. But given the considerations sketched above, there is a particularly strong case to be made for it.

⁴⁴ For some interesting ideas, see Michael L. Anderson, "Mining the Brain for a New Taxonomy of Mind," *Philosophy Compass* 10, no. 1 (2015): 68–77; and Felipe De Brigard, "Cognitive Systems and the Changing Brain," *Philosophical Explorations* 20, no. 2 (2017): 224–41.

⁴⁵ Desideratum 4 is therefore satisfied. The important point here, however, is that compatibility, or accordance, with our knowledge of neural mechanisms is not a sufficiently strong condition.

⁴⁶ A related worry pertains to the fact that Cheng and Werning describe one *possible* class of neural mechanisms for coding sequences. While the evidence they provide for their model is impressive, there are a *number* of models/descriptions of sequence-coding mechanisms in the literature. However, I am bracketing this issue here.

and Werning recognize,⁴⁷ however, kinds investigated by the special sciences are unlikely to possess essences. Given the natural variability of biological and psychological individuals, instances of these kinds will only *tend to* share relevant properties.⁴⁸ The number of co-occurring properties, and potentially the mechanisms that maintain the homeostatic unity, will typically vary across instances. The HPC view was designed specifically to deal with such variability, preserving the idea that there are natural kinds in the domains investigated by the special sciences. Accordingly, HPC kind concepts are not defined by a set of necessary and sufficient conditions. Rather, they have a *prototype* structure, reflecting the inevitable messiness of the biological world. As Boyd emphasizes, any further refinement of the kinds will artificially obscure the inevitable indeterminacy in the extension of special science kind terms. The pursuit for such “refinement”—that is, for necessary and sufficient conditions—is diagnosed as a “holdover from traditional empiricist conceptions of linguistic precision which must be abandoned.”⁴⁹

Set upon this backdrop, Cheng and Werning’s reliance on the Sequence Analysis is particularly puzzling.⁵⁰ As we have seen, to establish that the class of episodic memories is explanatorily minimal and maximal, the authors attempt to show that the properties delineated in the analysis are individually necessary and jointly sufficient. Thus, any violation of conditions S1–S7 would lead to a deficiency of episodic memory (minimality) and only episodic memories satisfy all conditions (maximality). This approach sacrifices much of the theoretical nuance of the HPC view. Consider the treatment of explanatory minimality. “A mnemonic representation,” the authors argue, “fails to be proper episodic memory if one or more of the conditions (S1)–(S7) is violated, even in cases where the content of the mnemonic representation is veridical.”⁵¹ This kind of stringency may be appropriate in the delineation of conceptual clusters, but it seems decidedly out of place when we are dealing with mechanistically unified *causal* clusters. Again, this is the bread and butter of Boyd’s view: given the variability and multiple realizability of psychological kinds, episodic memories—considered as HPC kinds—will share relevant properties only imperfectly. And in some circumstances, there may simply be no fact of the matter

⁴⁷ Cheng and Werning, “What Is Episodic Memory,” 1358.

⁴⁸ See Boyd, “Realism,” on why instances of a kind will share properties only imperfectly.

⁴⁹ Boyd, “Realism,” 142.

⁵⁰ Cheng and Werning recognize that essentialism is too restrictive to admit for natural kinds in the special sciences (“What Is Episodic Memory,” 1358), yet on the very next page venture on to a pursuit for necessary and sufficient conditions for episodic memory (1359). This is perplexing.

⁵¹ 2016, 1360f.

whether a particular mental state is an episodic memory.⁵² Note: the point here is not that episodic memories don't have essences. Cheng and Werning, after all, may be right that all and only proper episodic memories possess a specific set of properties. The point is rather that an appeal to homeostatic mechanisms is unlikely to anchor such essences.⁵³ The search for necessary and sufficient conditions for episodic memory, then, is in a direct tension with a foundational principle of the HPC view. What about explanatory minimality and maximality, however? What role do these conditions play in the HPC theory? Pace Cheng and Werning, the maximality condition isn't there to necessitate the inclusion of a set of jointly sufficient conditions for membership in the kind. Its role, rather, is to ensure that the many subsets of the relevant kinds don't end up being counted as natural kinds themselves. To go back to our example once again: the causally relevant properties that lions tend to share will also be shared by sleepy lions,⁵⁴ and for the same reason: the underlying homeostatic mechanism. The maximality condition—stipulating that no superset of the class should have the same explanatory potential—acts as a safeguard, disqualifying *sleepy lion* as a candidate for natural kind-ness. From this perspective, it is easy to see why explanatory minimality, *properly understood*, is not a relevant condition of the HPC view. Given any natural kind class, there will be many subsets of the class with the same explanatory potential. Sleepy lions, thirsty lions, and lions that live in San Diego share the properties that figure in inductively relevant generalizations. This does not disqualify *lion* as natural kind candidate.

In our case, likewise, it matters only if the class of episodic memories is explanatorily *maxi-*

⁵² As Boyd (1999, pp.143-144) clarifies, imperfect homeostasis is nomologically possible or actual. A thing may display some but not all of the relevant properties (i.e. the properties that co-occur in an important number of cases; similarly, some but not all of the relevant underlying homeostatic mechanisms may be present. In cases of imperfect homeostasis, the relative importance of the various properties and mechanisms - in determining whether a particular entity belongs to a kind - is decided in an a posteriori manner (i.e. by consulting the relevant theory for the domain). Importantly, there will be (many) cases of extensional indeterminacy, which are not resolvable, even with access to all the relevant facts and all the true theories. In these cases, no "rational considerations" will dictate whether or not a thing should be considered a member of a given kind (1999, p.144). For example, the necessary indeterminacy in extension of species terms is a consequence of Darwinian evolutionary theory: "speciation depends on the existence of populations which are intermediate between the parent species and the emerging one" (Boyd 1991, p.142). Attempts to resolve such indeterminacy - by further 'sharpening' of the kind concepts - will only artificially obscure their natural "family resemblance" structure. Whether such extensional indeterminacy exists in the case of episodic memory is an open question.

⁵³ Some significant issues, specifically pertaining to the multiple realizability of psychological kinds, lurk in the background here. A full exploration of these issues is beyond the scope of this essay. In any case, the main point—that psychological kinds are unlikely to possess essences—is granted by Cheng and Werning.

⁵⁴ Excluding being *sleepy*.

mal. If it is, then there must not be a superset with the same explanatory potential, the members of which are likely to share the same causally relevant properties. Whether such a superset exists, as Cheng and Werning note, is a matter of some controversy, with *declarative memory* and *mental time travel* typically put forward as prime candidates.⁵⁵ This issue, however, is inextricably linked to the provision of a relevant property cluster. Accordingly, investigations of maximality will inherit the problems sketched in the previous section. Thus, if there are competing analyses that (a) satisfy the tracking condition, and (b) subserve different explanatory projects, there will also typically be incompatible, yet equally satisfying, verdicts on maximality. We saw this in the context of the debate between causal and simulation theories. If we consider pastness and the presence of memory traces to be key properties of episodic memories, then it is unlikely that a superset kind like *mental time travel* will carry the same explanatory potential. In contrast, if we opt for a less restrictive analysis, then the case for *mental time travel* as a natural kind will be much stronger. This problem is only exacerbated by the prototype structure of HPC kind concepts. In some cases, it will be exceptionally difficult (impossible?) to determine whether two classes have the same explanatory potential.⁵⁶ There are some deeper issues lurking in the background here. Given the natural variability and the purported multiple realizability of psychological kinds, there is a reasonably strong case to be made that HPC taxonomies cannot in principle satisfy the arbitration condition.⁵⁷ While this issue lies beyond the scope of this comment, it is worth mentioning that memory researchers have been implicitly dealing with it for quite some time. Thus, the behavioral, mechanistic, and neural variability of memory kinds was one of the primary reasons for adopting the memory *systems* approach, which has dominated the recent discussion. As Schacter and Tulving point out in their seminal contribution, a memory system will typically comprise a variety of neural and cognitive mechanisms, working together and in accordance with some important principles. And, while episodic memories may have a number of characteristic properties,⁵⁸ it would be very surprising if these were clustered together by the operation of one class of causal

⁵⁵ See Michaelian, *Mental Time Travel*.

⁵⁶ This may entail that the notion of “same explanatory potential” is fundamentally problematic. I postpone the discussion of this issue to a future occasion.

⁵⁷ See Craver, “Mechanisms and Natural Kinds.”

⁵⁸ Endel Tulving lists 28 important features of the episodic memory system, pertaining to the type of information/content, the character of computational operations, and the relevant applications (*Elements of Episodic Memory* [Oxford: Oxford University Press, 1983]). Cheng and Werning (“What Is Episodic Memory,” 1349) characterize Tulving’s approach as “descriptive.” While Tulving was providing a description of the features, however, this was a necessary component in the *explanatory* project of identifying and distinguishing the episodic memory system from other cognitive systems.

mechanism, as in Cheng and Werning's proposal. This is why identifying a memory system requires, at the very least, the specification of a large number of class-inclusion operations, distinguishing properties at multiple levels of organization as well as convergent dissociations from other memory systems.⁵⁹ This approach may not appease the major worries, but it is an important step towards satisfying the arbitration condition.

Conclusion

Cheng and Werning describe their project as “inherently interdisciplinary,” navigating between the twin cliffs of philosophical analysis and neuroscientific description. Genuine interdisciplinarity, however, requires more than paying attention to evidence from a variety of sources. It also obliges us to jettison the argumentative divide-and-conquer strategy, which often relegates either philosophy or neuroscience to the position of a Lockean “under-laborer.” To properly navigate between the cliffs, we have to “mine the brain” for new taxonomies of the mind,⁶⁰ but also work together to explore both the terms of engagement and the conditions for success. When does an appeal to neural mechanisms or systems license the acceptance or revision of psychological categories? What role does philosophical analysis play in the construction of cognitive ontologies?⁶¹ What is the relationship between conceptual and causal property clusters? These questions are highly complex and the answers will likely elude us for some time. To advance our understanding of mind-brain relationships, however, we must directly engage with them. Cheng and Werning's proposal, while innovative and empirically detailed, ultimately fails to do so. Anchored on the pursuit of necessary and sufficient conditions for episodic memory, it doesn't provide the requisite theoretical resources for arbitration between rival cognitive taxonomies.

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⁵⁹ These are the three criteria for the identification of memory systems put forward by Daniel L. Schacter and Endel Tulving (“What Are the Memory Systems of 1994?” In *Memory Systems 1994* [Cambridge, MA: MIT Press, 1994, 1–38). For discussion, see Michaelian, “Is Memory a Natural Kind?”

⁶⁰ See Anderson, “Mining the Brain.”

⁶¹ See Anelli Janssen, Colin Klein, and Marc Slors, “What Is a Cognitive Ontology, Anyway?” *Philosophical Explorations* 20, no. 2 (2017): 123–28.

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