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Commentary

COMMENTARY

Scene Construction and Relational Processing: Separable Constructs?

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Abstract

Imagining hypothetical events often entails the construction of a detailed mental simulation. Despite recent advances, debate still surrounds the fundamental constructive process underpinning simulations supported by the hippocampus. Palombo et al. (2016) report findings that suggest that scene construction drives hippocampal engagement during imagination. However, they fail to consider the findings of a previous study using an extremely similar manipulation that generated similar hippocampal findings, but was interpreted in terms of event specificity and relational processing (Addis et al. 2011). While we applaud the general approach taken by Palombo et al. in attempting to distinguish components of mental simulation, a comparison of these 2 papers has brought into sharp relief how the lack of a common theoretical framework can result in significant interpretative ambiguities. In this commentary, we attempt to identify and clarify these as yet unresolved conceptual issues that will require empirical and theoretical attention in future research.

Key words: episodic, hippocampus, imagination, scene construction, simulation

Imagining hypothetical events often entails the construction of a detailed mental representation referred to as an episodic simulation (Szpunar et al. 2014). The last decade has seen significant progress toward understanding the cognitive and neural processes underlying episodic simulation, including engagement of a "core" neural network (including the medial temporal lobes and other default mode network regions) when imagining and remembering (Schacter et al. 2012) the reliance on episodic and semantic memory representations to provide the content of simulations (Schacter and Addis 2007; Irish and Piguet 2013; Klein 2013), and the importance of constructing a scene within which to situate a simulated event (Hassabis and Maguire 2007; Maguire and Mullally 2013). While these factors are common to all forms of episodic simulation and memory, irrespective of temporal orientation (Schacter et al. 2012), some studies have found that imagining events is associated with increased activation of the medial temporal lobes—in particular, the hippocampus—relative to remembering past events (see Benoit and Schacter 2015, for a meta-analysis).

Despite these advancements, debate still surrounds the fundamental constructive process underpinning simulation that is supported by the hippocampus. The constructive episodic simulation hypothesis (Schacter and Addis 2007) posits that the construction of simulations relies on relational processing (Cohen and Eichenbaum 1993; Eichenbaum and Cohen 2014), while the scene construction theory (Hassabis and Maguire 2007; Maguire and Mullally 2013) holds that spatial and scene-related processing is key. A recent paper by Palombo et al. (2016), and its comparison to an earlier paper by Addis et al. (2011), has brought into sharp relief the implications of these contrasting theoretical positions, and how the lack of a common theoretical framework within which to situate experimental findings can result in significant interpretative issues. This commentary attempts to identify and clarify these issues.

In Palombo et al.'s (2016) study, participants completed an imagination task in which precise scene cues were presented and participants made forced-choice self-referential decisions that relied on simulation. Critically, the cues presented modulated the type—and degree—of simulation required to answer the question (e.g., high scene construction: "Imagine a pan catches fire in your kitchen. What do you envision?"; low scene construction: "Imagine that you're a part-time teacher. What are you most likely to teach?"). In 2 other conditions that used different items with low scene construction demands, Palombo et al. manipulated whether events were imagined in the present or future. According to the authors, this experimental design "manipulat[es] demands on scene construction and future projection, an approach not previously taken" (p. 2). Their results showed that the hippocampus was more engaged during the high versus low scene construction condition but not in the future versus present condition. We agree that jointly manipulating these 2 variables within the same experimental design has not been reported previously and constitutes a commendable feature of their study. Previously, however, in a study not cited by Palombo et al. we used an experimental manipulation that is extremely similar to the manipulation that Palombo et al. refer to as high scene construction versus low scene construction—with one condition eliciting the generation of specific events and the other general events, as did the manipulations used by Palombo et al.—and reported very similar hippocampal results (Addis et al. 2011). However, we referred to this manipulation in terms of event specificity rather than scene construction demands. Specifically, our study required participants to remember past and imagine future events that were either specific (i.e., an episodic representation with a specific spatiotemporal context) or general (i.e., a nonepisodic representation such as a routine); although our cues were nouns, the simulations elicited were very similar to the scenarios specified in Palombo et al.'s cues. We argued that this manipulation modulates the episodicity of the event and the associated relational processing required to produce a specific episode. That is, the critical mechanism underlying the imagination of a coherent event with a specific spatiotemporal context (Tulving 1983) is the relational processing required to construct that specific spatiotemporal context and link it to other features of the event (e.g., people, objects, emotions). In contrast, we suggested that imagining a general event relies more on previously experienced routines, is based more on conceptual and semantic information (Conway and Pleydell-Pearce 2000), and thus places fewer demands on relational processing. While it is possible that general events require just as much relational processing, albeit semantic/conceptual relations, specific events are typically rated as comprising a higher amount of detail than general events (Addis et al. 2004, 2011; Holland et al. 2011), which may suggest that specific representations contain more relations (though we note that the link between detail ratings and the number of relations is currently tentative, and that detail ratings could also reflect, at least in part, the amount of scene processing).

And herein lies the problem at hand: In both studies (Addis et al. 2011; Palombo et al. 2016), episodicity and scene construction are confounded. Specific events are high in episodicity (and thus require extensive relational processing) and grounded in a spatial context (and thus require scene construction); nonspecific events are low in episodicity and not tied to a coherent spatial scene, therefore requiring less relational processing and scene construction (see also Conway and Pleydell-Pearce 2000). Given this confound, Palombo et al. (2016, p. 9) do not have a strong basis to claim that their "findings elucidate the specific component processes of imagination that drive [medial temporal lobe] engagement," which they regard as scene construction. Palombo et al. actually do refer to this confound in their discussion by suggesting that their manipulation could also be couched in terms of event specificity or episodicity rather than scene construction, although in doing so they fail to acknowledge that the episodic specificity of imagined future events in fact had already been shown to modulate hippocampal activity (Addis et al. 2011). In addition, Palombo et al. briefly mention that their findings are compatible with a relational processing account, yet fail to provide a rationale for choosing to interpret their findings in terms of scene construction. Conversely, in Addis et al. (2011) we did not discuss scene construction as a possible interpretation of the increased hippocampal activity evident for specific future events, although in hindsight it would have been helpful to have done so.

The crux of the issue is whether scene construction and the relational processing underlying episodicity are separable constructs. Maguire and Mullally (2013) argued that indeed they are. They state that scenes are the "primary currency" of the hippocampus (p. 1187) and that they are fundamental for imagining and remembering events by providing the spatial template within which an event is played out. As such, they argue, scene construction is a process distinct from relational processing (Maguire and Mullally 2013, p. 1182 and p. 1186). In contrast, relational processing is central to our constructive episodic simulation hypothesis (Schacter and Addis 2007), and can be viewed as a fundamental mechanism responsible for both scene construction and the construction of a specific event. However, we believe that our theoretical perspective is not mutually exclusive with scene construction theory, but rather emphasizes a more general characterization of event construction that includes, but is not limited to, scene construction: scenes are but one type of information incorporated into a specific event through a constructive process that relies on forming relations. Indeed, others have posed the same idea. For instance, the emergent memory account (Graham et al. 2010) argues that the hippocampus is critical for creating "complex conjunctive scene representations" (p. 832), including the unique relationships between the objects comprising a scene and oneself. That is, we are arguing that the relational processes posited by the constructive episodic simulation hypothesis can function on multiple levels of a specific imagined (or remembered) event: at the level of scenes, relational processing is required to integrate objects and spatial features of a scene; at the level of events, this mechanism is involved with binding disparate details (people, actions, emotions, etc.) together to form coherent and dynamic events. We think that it is this point that is missed in Palombo et al.'s (2016) emphasis on scene construction.

We do not contest that imagined and remembered episodes must be situated within a scene; space is intrinsic to our experiences in reality and thus also to our simulations of reality. However, the simulation of specific episodes, which are often multifaceted, dynamic scenarios, requires the incorporation of more than just spatial information. Episodic memories and simulations are characterized by a spatiotemporal context (Tulving 1983). Indeed, hippocampal time cells (MacDonald et al. 2011) may contribute directly to this important aspect of episodicity. More recent evidence indicates that the hippocampus represents simulations involving the integration of not only spatial information, but also temporal information and specific goal-states (Brown et al. 2016). Moreover, specific episodes are characterized by the integration of multimodal details—not only scene-relevant details but also nonscene details such as people, objects, dialog, emotion, and so forth. Integrating these multimodal details into a coherent episode inherently requires relational processing (Cohen and Eichenbaum 1993), and indeed the amount of hippocampal activity modulated with the amount of detail comprising these events (Addis et al. 2004; Addis and Schacter 2008). Interestingly, scene construction theory explicitly recognizes that "additional processes" on top of scene construction are required for a scene to be transformed into an event, and that such processing may also be localized to the hippocampus (Maguire and Mullally 2013, p. 1186). We believe, however, that a parsimonious theoretical framework is one in which a single mechanism—relational processing—underpins both scene and event construction (for a more general discussion of related points, see Eichenbaum and Cohen 2014).

Proponents of the scene construction theory argue that an important commonality across different forms of simulation (e.g., imagined events, remembered events) is the generation of a scene. However, this account does not adequately explain differences between imagined and remembered events, such as differential hippocampal activity during imagination. The constructive episodic simulation hypothesis, however, can explain these differences: imagining future events requires more intensive relational processing than remembering events simply because new relations must be formed between often disparate elements (including—but not limited to—relations required to construct a novel scene). Thus, this account also predicts that when the episodic and relational demands are similar across different forms of simulation (e.g., past, present, future), there should be no differences in hippocampal activity. One example where past and future events are associated with similar levels of hippocampal activity is when events in both temporal directions are imagined, likely equating the relational demands (Addis et al. 2009; see also Andrews-Hanna et al. 2010 for related evidence). Although mental time travel was required both when imagining in the future and the past, Palombo et al. (2016) observed no differences in hippocampal activity even when mental time travel was only required in one condition (imagining future events) but not in another (imagining present events; see also Andrews-Hanna et al. 2010 for related evidence), suggesting that hippocampal activity is more responsive to the need to imagine a novel event than the temporal direction per se (Addis et al. 2009), or the presence of a temporal component altogether (Andrews-Hanna et al. 2010; Palombo et al. 2016). It is important to note, however, that the issue of temporality is independent of the larger debate between scene construction and relational processing accounts; while the constructive episodic simulation hypotheses predict greater hippocampal activity for imagined future events relative to remembered past events, it attributes these differences to the increased relational processing load associated with imagining novel events and not to mental time travel per se.

Another interesting observation to arise out of the comparison of Addis et al. (2011) and Palombo et al. (2016) is that a commitment to a given theoretical position may lead researchers to not only interpret ambiguous findings in a particular light, but also to only collect data that are relevant to the preferred theoretical framework. For instance, Addis et al. collected detail ratings and compared these across conditions; Palombo et al. collected scene ratings. Unfortunately, this difference in the data collected prevents a comprehensive comparison of the 2 studies; we cannot know whether, like Palombo et al.'s finding, the specific and general conditions in Addis et al. differed in terms of scene construction demands, and vice versa with respect to detail.

In summary, while we applaud the general approach taken by Palombo et al. (2016) in attempting to distinguish components of mental simulation, we think that it is important to consider their findings in relation to the highly similar earlier findings of Addis et al. (2011) and the alternate theoretical account that we put forward because doing so brings into sharp focus as yet unresolved conceptual issues. Ultimately, experimental work—motivated by a conceptual framework that clearly delineates the similarities and differences between scene construction and relational processing accounts —is needed to develop a critical test that can adjudicate between these 2 theories.

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Notes

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