



Cognitive mechanisms of episodic simulation in psychiatric populations

Amanda M. Brunette^{a,*}, Daniel L. Schacter^b

^a VA Boston Healthcare System, Psychology Service, 150 South Huntington Avenue, Boston, MA, 02130, United States

^b Harvard University, Department of Psychology, William James Hall, 33 Kirkland Street, Cambridge, MA, 02138, United States

ARTICLE INFO

Keywords:

Prospection
Episodic retrieval
Scene construction
Mental imagery
CaRFAX model
Narrative style

ABSTRACT

Episodic simulation is the construction of a mental representation of a specific autobiographical future event. Episodic simulation has increasingly been studied in psychiatric populations. Here we 1) review evidence indicating that episodic simulation is compromised in patients with depression, anxiety, schizophrenia, bipolar disorder, and PTSD; and 2) consider several potential cognitive mechanisms of episodic simulation in psychiatric populations: episodic retrieval, scene construction, mental imagery, components of the CaRFAX model (i.e., capture and rumination, functional avoidance, and executive functioning), and narrative style. We evaluate evidence regarding these mechanisms across psychiatric populations, and identify areas of future research. Understanding the factors that contribute to episodic simulation impairment in psychiatric populations may lead to targeted and effective treatment approaches.

1. Introduction

Prospection is defined as the ability to mentally represent what might happen in the future (Gilbert & Wilson, 2007; Seligman, Railton, Baumeister, & Sripada, 2013; Szpunar, Spreng, & Schacter, 2014). Prospection, also sometimes referred to as “episodic future thinking” (Atance & O’Neill, 2001; Schacter, Benoit, & Szpunar, 2017), has become an increasingly important topic of research in psychology and neuropsychology during the past two decades. Szpunar et al. (2014) proposed a framework that distinguishes among four major forms of prospection: simulation, prediction, intention, and planning. They also delineated episodic and semantic forms in each domain of prospection, where episodic refers to specific autobiographical events in the future, and semantic refers to general or abstract states of the world in the future.

The focus of the current paper is on episodic simulation, defined as the construction of a mental representation of a specific autobiographical future event (also referred to as “future simulation” below) (Atance & O’Neill, 2001; Schacter, Addis, & Buckner, 2008; Szpunar, 2010; Szpunar et al., 2014). Much of the early work on episodic simulation stemmed from investigations of episodic simulation deficits in psychiatric conditions such as in individuals with dysphoria (MacLeod & Cropley, 1995) and suicidal patients (Williams et al., 1996). Subsequently, cognitive psychologists and neuropsychologists have extensively studied episodic simulation through investigation of its

underlying cognitive mechanisms, its neural correlates, and disorders of episodic simulation in neurological populations (for reviews, see Buckner & Carroll, 2007; Irish & Piolino, 2016; Klein, 2013; Schacter & Addis, 2007; Schacter et al., 2012; Schacter et al., 2017; Ward, 2016).

Episodic simulation has been increasingly examined across psychiatric populations, including depression (Addis, Hach, & Tippett, 2016; Parlar et al., 2016), anxiety (Morina, Deeproose, Pusowski, Schmid, & Holmes, 2011; Wu, Szpunar, Godovich, Schacter, & Hofmann, 2015) bipolar disorder (Di Simplicio et al., 2016), schizophrenia (Raffard et al., 2016; Wang et al., 2017), and PTSD (Brown et al., 2016). Compromised episodic simulation has important clinical implications in psychiatric populations because of its relevance for various adaptive cognitive and behavioral functions, as well as for psychological well-being (Schacter et al., 2017). For example, brief training to increase the specificity of future simulations in a non-clinical population led to improved problem-solving for future worrisome events, reappraisal of negative outcomes, and decreased anxiety and negative affect within a test session (Jing, Madore, & Schacter, 2016). Engaging in future simulation has been linked to increased perceived control over future events (Boland, Riggs, & Anderson, 2018; Hallford, Yeow, et al., 2020) and anticipated pleasure for future events (Hallford, Farrell, & Lynch, 2020; Hallford, Yeow, et al., 2020). Additionally, future simulation has been associated with decision-making (Benoit, Gilbert, & Burgess, 2011; Peters & Büchel, 2010) and social problem-solving (Madore & Schacter, 2014). Interventions that improve specificity of future simulations may

* Corresponding author.

E-mail addresses: abrunette@kumc.edu (A.M. Brunette), dls@wjh.harvard.edu (D.L. Schacter).

<https://doi.org/10.1016/j.brat.2020.103778>

Received 11 April 2020; Received in revised form 1 November 2020; Accepted 17 November 2020

Available online 23 November 2020

0005-7967/© 2020 Elsevier Ltd. All rights reserved.

allow patients with psychiatric conditions to better engage in and benefit from empirically-supported psychological interventions. For example, simulating the future increases the likelihood of completing an intended task (Altgassen et al., 2015; Neroni, Gamboz, & Brandimonte, 2014; Terrett et al., 2016), and planning future tasks or activities is a core component of cognitive behavioral therapy.

Research is in the early stages of investigating cognitive mechanisms that contribute to episodic simulation impairment in psychiatric disorders. The aim of this article is to review candidate cognitive mechanisms of episodic simulation impairment in psychiatric conditions based on the existing literature. Specifically, this paper will consider episodic simulation assessment and performance in the main psychiatric conditions in which episodic simulation has been studied: depression, anxiety, bipolar disorder, schizophrenia, and PTSD. Several distinguishable though related cognitive mechanisms of episodic simulation impairment in psychiatric conditions will be discussed: episodic memory retrieval, scene construction, mental imagery, components of the CaRFAX model (Williams, 2006; Williams et al., 2007) (capture and rumination, functional avoidance, and executive control dysfunction), and narrative style. A narrative review was conducted rather than a systematic review or meta-analysis because of the few number of studies per psychiatric condition and mechanism. Understanding the cognitive mechanisms of episodic simulation impairment in psychiatric populations can both help to advance theoretical analyses and inform interventions or cognitive rehabilitation in these populations.

2. Episodic simulation assessment and performance in psychiatric populations

2.1. Assessing episodic simulation in psychiatric populations

Researchers have assessed episodic simulation using both *objective* measures, which involve scoring descriptions of simulated future events based on specific criteria, and *subjective* measures, where participants rate their subjective experience (such as the level of detail or vividness) of an imagined future scenario. The main objective and subjective approaches to assessing episodic simulation are discussed below, though studies commonly use variants of these measures.

Objective measures of future simulation. The two main objective measures used to assess episodic simulation are the adapted Autobiographical Interview (AI) (Addis, Wong, & Schacter, 2008; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002) and the modified Autobiographical Memory Test (AMT) (Williams et al., 1996). Both the AI and AMT were originally devised to investigate memories of past personal experiences. In the adapted AI task and AMT, participants are given cues (a word or a short phrase), and in response to each cue they are asked to imagine and describe specific future events in as much detail as possible (and may also be asked to retrieve autobiographical memories). Some studies include valenced cues (positive, negative, and/or neutral cue words or phrases). In the adapted AI task, participant responses are coded based on the internal details and external details (Addis et al., 2008). Internal details are details tied to a specific time and place such as who will attend the event, what will occur, where the event will take place, and when the event will happen. External details include semantic knowledge, related facts, reflections on the event, off-topic details, repetitions, and references to other events. In the AMT, responses are coded based on the level specificity of their future descriptions (Williams et al., 1996). Notably, the adapted AI and AMT scoring differ because the adapted AI task measures the number of details within an event, whereas the AMT measures the presence or absence of specific events. Another objective measure is the Sentence Completion for Events in the Future Test (SCEFT) (Anderson & Dewhurst, 2009). During the SCEFT, participants are provided with sentence cues (which are sometimes positively, negative, or neutrally valenced depending on the study) and participants are asked to finish the sentences by generating possible future scenarios. Responses are coded

based on the level of specificity of their future descriptions. Episodic simulation has also been assessed by measuring the coherence (Huddy, Drake, & Wykes, 2016) and clarity (Painter & Kring, 2016) of participants' descriptions of future events.

A task related to the adapted AI task and the modified AMT is referred to as a scene construction task (Hassabis, Kumaran, Vann, & Maguire, 2007). Participants are asked to simulate both atemporal (i.e., scenarios not tied to the past or future; e.g., "Imagine you're lying on a deserted white sandy beach in a beautiful tropical bay") and future scenarios (e.g., "Imagine something you will be doing this weekend") in response to short verbal cues. Responses are scored to determine the richness of the atemporal and future descriptions based on both subjective ratings of the participants' experience and objective ratings by the researchers (Hassabis et al., 2007). Subjective ratings include participant ratings of the salience, sense of presence, and spatial coherence (an index incorporating ratings of the spatial integration of their simulation) of the simulated events. Objective components include the quality of the simulation and content included (i.e., spatial references, entities present, sensory descriptions, and thoughts/emotions/actions). Overall richness of the atemporal and future descriptions is scored using an "experiential index," which incorporates subjective and objective ratings.

Subjective measures of future simulation. Studies have also measured participants' subjective experiences during episodic simulation. Early work measured the ability to "re-experience" the past and "pre-experience" the future in non-clinical populations (D'Argembeau & Van der Linden, 2004, 2006). Specifically, D'Argembeau and Van der Linden (2004) and D'Argembeau and Van der Linden (2006) asked participants to simulate specific events in the past and future in as much detail as possible, and then rate various aspects of their subjective experience using questionnaires adapted from memory research, such as the Memory Characteristics Questionnaire (Johnson, Foley, Suengas, & Raye, 1988) and the Autobiographical Memory Questionnaire (Rubin, Schrauf, & Greenberg, 2003). These measures or similar measures have been used in psychiatric populations. While there is variability between studies regarding what is subjectively rated by participants, participants are commonly asked to rate their subjective experience on the amount of overall detail, amount of sensory details (such as visual or auditory), clarity of location/spatial details, vividness, specificity, emotional intensity, emotional valence, visual perspective (field or observer), representation of the self (*self-referential information*), representation of others (*other-referential information*), and ability to "pre-experience" the future simulation (such as "how well can you imagine experiencing the event") (for example, see Addis et al., 2016; Anderson & Evans, 2015; de Oliveira, Cuervo-Lombard, Salame, & Danion, 2009; Finnbogadóttir & Berntsen, 2014; Painter & Kring, 2016; Raffard et al., 2016; Winfield & Kamboj, 2010). One study asked participants to rate their experience of simulating a specific future event on "coherence" (Anderson & Evans, 2015). Coherence was assessed by participants rating the phrase "The order of events is clear and tells a coherent story" on a Likert Scale (1 = Not at all, 7 = Extremely). A final subjective measure commonly used in studies of psychiatric populations is the Prospective Imagery Task (PIT) (MacLeod, 1996; Stöber, 2000). In this task, participants are given cues consisting of short descriptions of future scenarios and are then asked to imagine the scenario happening to them in the future. The cues have either positive or negative valence. Participants rate the vividness of the scenario on a Likert scale.

2.2. Psychiatric populations exhibit compromised episodic simulation

Objective performance. The majority of studies using objective tasks found that psychiatric populations exhibit impaired episodic simulation (Table 1). In a meta-analysis examining multiple objective measures, Hallford, Austin, Takano, and Raes (2018) found that individuals with a psychiatric diagnosis had less specific and detailed episodic future thinking, and sub-group analyses suggested that there

Table 1
Performance on selected objective measures of future simulation in psychiatric populations.

Study	Sample	Future Simulation Measure	Cue Valence	Scoring Method	Selected Findings	Effect size
Addis et al. (2016)	Patients with current or past depressive symptoms versus controls	Modified AMT	Positive, negative, and neutral	Coded as specific, categorical, extended, or as other non-specific information	Depressive group < controls for specific events Did not analyze interaction between group and cue valence	$d = -4.47$ across all cues
Anderson et al., 2015	Participants with dysphoria versus controls	Described specific near and distant future events	No cues	Coded as specific, categoric, or extended	Participants with dysphoria = controls for specific events	Not available
Anderson et al. (2016)	Participants with dysphoria versus controls	SCEFT	Cues without valence in Experiment 1 Positive and negative cues in Experiment 2	Coded as specific, categoric, extended, or semantic associates	Participants with dysphoria = controls for specific events in response to cues without valence Participants with dysphoria < controls for specific events in response to positive and negative cues	Experiment 1: Cues without valence: $d = 0$ Experiment 2: Positive cues: $d = -0.72$ Negative cues: $d = -0.73$
Belcher et al., 2014	Patients with depression versus controls	Modified AMT	Positive and negative	Coded as specific, omission, or general	Patients with depression < controls for specific events Did not analyze interaction between group and cue valence	$d = -0.85$ across all cues
Blix et al., 2011	Participants with history of trauma versus controls	Modified AMT	Positive, negative, and neutral	Coded as specific, categorical, extended, semantic associate, or as a non-response	Patients with a history of trauma = controls for specific events No significant interaction between group and cue valence	$d = 0.16$ across all cues
Boelen et al. (2014)	Non-clinical population	SCEFT-2	Does not mention valence of cues	Coded as specific, extended, categoric, or semantic association	No significant association between specificity of future simulations and anxiety symptoms.	$r = .02^*$
Boulanger et al. (2013)	Patients with bipolar disorder versus controls	Modified AMT	Positive and negative	Coded as specific, overgeneral, or a failure	Patients with bipolar disorder < controls for specific events No significant interaction between group and cue valence	Positive cues: $d = -1.26$ Negative cues: $d = -0.95$
Brown et al. (2013)	Patients with PTSD versus controls	Modified AMT	Neutral	Coded as specific, intermediate, general, or no response	Patients with PTSD < controls for specific events across recent and remote future events	Recent future events: $d = -2.26$ Remote future events: $d = -1.84$
Brown et al. (2014)	Patients with PTSD versus controls	Adapted AI task	Neutral	Coded into internal and external details	Patients with PTSD < controls for internal details	Not available
Brown et al. (2016)	Patients with PTSD versus controls	Modified AMT	Positive and negative	Coded as specific, categoric, or extended	Patients with PTSD = controls for specific events Did not examine interaction between group and cue valence for specificity findings	Not available
Chen et al. (2016)	Patients with schizophrenia and individuals with schizotypal personality disorder proneness versus controls	SCEFT	Does not mention valence of cues	Coded as specific, extended, categoric, semantic associates or omission	Patients with schizophrenia < controls for specific events	$d = -0.76$
D'Argembeau et al. (2008)	Patients with schizophrenia versus controls	Modified AMT	Positive and Negative	Coded as specific, extended, categoric, or omission	Patients with schizophrenia < controls for specific events No significant interaction between group and cue valence	$d = -2.15$ across all cues
de Oliveira et al., 2009	Patients with schizophrenia versus controls	Described specific future events related to plans for close and distant periods	Does not mention valence of cues	Scored based on degree of specificity (from 0 = general information to 4 = detailed)	Patients with schizophrenia < controls	Close periods: $d = -1.08$ Distant periods: $d = -0.66$
Dickson et al., 2006	Participants with dysphoria versus controls	Modified AMT	Pleasant and unpleasant (depression and anxiety related)	Coded as specific, moderate, or general	Patients with schizophrenia < controls for specific future pleasant, depressive, and anxious experiences, and findings were most notable for pleasant experiences	Pleasant cues: $d = -3.02$ Depression-related cues: $d = -0.88$ Anxiety-related cues: $d = -1.11$
Dickson et al. (2009)	Non-clinical population	Modified AMT	Negative	Coded as specific, extended, or categoric	Anxiety symptoms were not significantly correlated with specificity (past and future events combined)	$r = -.03^*$
Hach et al. (2014)	Patients with depression versus controls	Modified AMT	Does not mention valence of cues	Coded as specific, categoric, extended, or non-specific information	Patients with depression < controls for specific events	$d = -4.00$

(continued on next page)

Table 1 (continued)

Study	Sample	Future Simulation Measure	Cue Valence	Scoring Method	Selected Findings	Effect size
Hallford, Mellor, et al. (2019)	Non-clinical population	Modified AMT	Positive, negative, and neutral	Coded as specific or non-specific	Anxiety induction did not result in a significant change in future thinking specificity Did not examine interaction between group and cue valence	Pre versus post-induction for the anxiety induction group $d = -0.12$ across all cues
Hallford, Barry, et al. (2020)	Patients with depression versus controls	Variant of Modified AMT	Positive	Coded as specific or non-specific	Patients with depression < controls for specific events	$d = -0.46$
Huddy et al. (2016)	Patients with schizophrenia or schizoaffective disorder versus controls	Described details of imaginary scenarios	Does not mention valence of cues	Scored on level of coherence	Patients with schizophrenia or schizoaffective disorder < controls	$d = -1.72$
King, Macdougall, Ferris, Herdman, and McKinnon (2011)	Patients with depression versus controls	Adapted AI task	Positive, negative, and neutral	Coded for internal and external details	Patients with depression < controls for internal details No significant interaction between group and cue valence	$d = -1.05$ across all cues
King, Williams, et al. (2011)	Patients with bipolar disorder versus controls	Adapted AI task	Positive, negative, and neutral	Coded for internal and external details	Patients with bipolar disorder < controls for internal details No significant interaction between group and cue valence	$d = -1.08$ across all cues
Kleim et al. (2014)	Patients with PTSD versus controls	Modified AMT	Positive and negative	Coded as specific or non-specific	Patients with PTSD < controls for specific events in response to positive cues; Patients with PTSD = controls for specific events in response to negative cues	Positive cues: $d = 0.57^*$ Negative cues: $d = 0.28^*$
Marsh et al. (2018)	Non-clinical population	Described specific future events	Neutral	Coded as specific or non-specific	Anxiety was significantly correlated with the number of specific future events produced	$r = -.197^*$
Malek et al. (2019)	Patients with schizophrenia versus controls	Described specific future events	Does not mention valence of cues	Coded for contextual details	Patients with schizophrenia < controls	Not available
Painter et al., 2016	Patients with schizophrenia or schizoaffective disorder versus controls	Described specific future events	Positive, negative, and neutral	Coded for time/place details and clarity	Patients with schizophrenia or schizoaffective disorder < controls for time/place details across all cues Patients with schizophrenia or schizoaffective disorder < controls for clarity in response to negative cues only	Completed memory task before prospection Time/place details Positive: $d = -0.51$ Negative: $d = -0.17$ Neutral: $d = -0.48$ Clarity Positive: $d = -0.30$ Negative: $d = -0.48$ Neutral: $d = 0$ Completed control task before prospection Time/place details Positive: $d = -0.41$ Negative: $d = 0.09$ Neutral: $d = -0.20$ Clarity Positive: $d = -0.29$ Negative: $d = -0.64$ Neutral: $d = -0.18$
Parlar et al. (2016)	Trauma-exposed patients with depression versus controls	Adapted AI task	Positive, negative, neutral	Coded for internal and external details	Patients with depression < controls for internal details in response to neutral cues (trending effect) Patients with depression = controls for internal details in response to positive and negative cues	Positive cues: $d = -0.40$ Negative cues: $d = -0.26$ Neutral cues: $d = -0.45$
Raffard et al. (2010)	Patients with schizophrenia versus controls	Scene construction and future simulation task (Hassabis et al., 2007)	Does not mention valence of cues	Coded for sensory descriptions, spatial references, and quality judgment	Patients with schizophrenia < controls across all selected outcomes	Sensory descriptions: $d = -0.85$ Spatial references: $d = -0.59$ Quality judgment: $d = -0.80$
Raffard et al. (2013)	Patients with schizophrenia versus controls	Adaptation of scene construction and future simulation task (Hassabis et al., 2007)	Positive and negative	Coded as specific, categoric, or extended	Patients with schizophrenia < controls for specific events, most notably in response to positive cues	Positive cues: $d = -1.15$ Negative cues: $d = -0.73$
Raffard et al. (2016)	Patients with schizophrenia versus controls	Described self-defining future events	None	Coded as specific or non-specific	Patients with schizophrenia = controls for specific events	$d = 0.05$

(continued on next page)

Table 1 (continued)

Study	Sample	Future Simulation Measure	Cue Valence	Scoring Method	Selected Findings	Effect size
Wang et al. (2017)	Patients with schizophrenia versus controls	Modified AMT	Positive, negative, neutral	Coded as specific or non-specific	Patients with schizophrenia < controls for specific events No significant interaction between group and cue valence	d = -0.65 across all cues
Williams et al. (1996)	Patients with suicidality (most of whom had a depression diagnosis)	Modified AMT	Positive, negative, neutral	Coded as specific, intermediate, or general	Patients with suicidality < controls for specific events No significant interaction between group and cue valence	Positive cues: d = -0.35 Negative cues: d = -0.31 Neutral cues: d = -0.71
Yang et al. (2018)	Patients with schizophrenia versus controls Individuals with social anhedonia versus controls	Described specific future events	Positive, negative, and neutral	Richness of thought/emotion details	Patients with schizophrenia < controls for richness of thought/emotion details Patients with social anhedonia < controls for richness of thought/emotion details No significant interaction between group and cue valence	<u>Schizophrenia findings:</u> Positive cues: d = -0.57 Negative cues: d = -0.41 Neutral cues: d = -0.34 <u>Social anhedonia findings:</u> Positive cues: d = -0.40 Negative cues: d = -0.68 Neutral cues: d = -0.42
Yang et al. (2019)	Patients with schizophrenia versus controls	Adapted AI task	Positive, negative, and neutral	Coded as internal and external details	Patients with schizophrenia < controls for internal details Did not examine interaction between group and valence	d = -0.72 across all cues

Note. Adapted AI task = Adapted Autobiographical Interview. Modified AMT = modified Autobiographical Memory Test. SCEFT = Sentence Completion for Events in the Future Test. "Not available" indicates that information was not provided to calculate effect size(s). Cohen's d effect sizes were calculated using means and pooled standard deviations. The following formula was used: $d = (M_1 - M_2) / SD$ pooled. *A few studies did not provide the relevant summary statistics, and as a result the effect size was obtained from the published manuscripts if they were available.

were significant effects for depression, bipolar disorder, and schizophrenia. In another meta-analysis, [Gamble, Moreau, Tippett, and Addis \(2019\)](#) observed that higher levels of depression were associated with reduced future specificity (including both subjective and objective measures) across patients with depression and non-clinical participants. The relationship between depression and future specificity did not differ as a function of type of future thinking (i.e., simulation, intention, or planning) ([Gamble et al., 2019](#), p. 825). Findings from studies using measures of episodic simulation in psychiatric populations will be discussed.

Using tasks that assessed the specificity of future simulations (modified AMT task, SCEFT, or slightly modified tasks), patients with depression ([Addis et al., 2016](#); [Belcher & Kangas, 2014](#); [Hach, Tippett, & Addis, 2014](#); [Hallford, Barry, et al., 2020](#)), suicidality (most of whom had a depression diagnosis) ([Williams et al., 1996](#)), dysphoria (see Footnote¹) ([Anderson, Boland, & Garner, 2016](#); [Dickson & Bates, 2006](#)), PTSD ([Brown et al., 2013](#); [Kleim, Graham, Fihosy, Stott, & Ehlers, 2014](#)), schizophrenia ([Chen et al., 2016](#); [D'Argembeau, Raffard, & Van der Linden, 2008](#); [de Oliveira et al., 2009](#); [Raffard, Esposito, Boulenger, & Van der Linden, 2013](#); [Wang et al., 2017](#)), and bipolar disorder ([Boulenger, Lejeune, & Blairy, 2013](#)) described future simulations with less specificity when compared to controls. Using the adapted AI task or slightly modified tasks, patients with depression ([King, Macdougall, Ferris, Herdman, & McKinnon, 2011](#); [Parlar et al., 2016](#)), PTSD ([Brown et al., 2014](#)), bipolar disorder ([King, Williams, et al., 2011](#)), and schizophrenia ([Yang et al., 2019](#)) provided future simulations with fewer internal details (i.e., details tied to a specific time and place) than

controls.

Using similar measures to the adapted AI task, patients with schizophrenia have been observed to include less time and place details ([Painter & Kring, 2016](#)) and contextual details ([Malek et al., 2019](#)) when describing the future. Patients with schizophrenia have also communicated future simulations with less coherence ([Huddy et al., 2016](#)) and clarity ([Painter & Kring, 2016](#)) than controls. [Yang et al. \(2018\)](#) found that patients with social anhedonia (according to self-report measures in a non-clinical population) and schizophrenia provided less rich future simulations. [Raffard, D'Argembeau, Bayard, Boulenger, and Van der Linden \(2010\)](#) observed that patients with schizophrenia provided future simulations with fewer sensory descriptions, fewer spatial references, and poorer quality than controls while using the scene construction task. Based on these studies and multiple meta-analyses, there is notable evidence for impaired future simulation in patients with psychiatric conditions or individuals with elevated psychiatric symptoms when using objective tasks.

A small selection of studies using the modified AMT or a similar task found no impairments in providing specific future simulations in individuals with dysphoria ([Anderson & Evans, 2015](#)), PTSD ([Brown et al., 2016](#)), schizophrenia ([Raffard et al., 2016](#)) and individuals with a trauma history (without a clinical diagnosis) ([Blix & Brennen, 2011](#)). Differences in methodology may have contributed to these findings. [Anderson and Evans \(2015\)](#) did not include emotionally valenced cues, which were included in the other studies that examined individuals with dysphoria ([Anderson et al., 2016](#); [Dickson & Bates, 2006](#)). [Brown et al. \(2016\)](#) had participants recall autobiographical memories before simulating specific events. This methodology may have allowed participants to practice providing specific details, potentially resulting in intact future simulation in patients with PTSD. [Raffard et al. \(2016\)](#) instructed participants to generate a future event that is related to their sense of self, is related to an "important and enduring theme, issue, conflict, or

¹ Studies that included participants with dysphoria were categorized into dysphoric and non-dysphoric groups based on a self-report measure of depression.

concern from one's life," generates strong feelings, and is an event they have thought about many times. Generating this type of future event may have allowed them to successfully engage in episodic simulation. Lastly, [Blix and Brennen \(2011\)](#) noted having methodological differences compared to other studies in PTSD, such as cueing participants to retrieve a specific future event on each trial. [Blix and Brennen \(2011\)](#) also examined patients with a trauma history, rather than patients with a diagnosis of PTSD. Although a few studies produced alternative findings, the majority of studies found that future simulation is impaired across multiple psychiatric populations when using objective measures of future simulation.

Finally, a number of studies have examined the relationship between the specificity of episodic simulations and anxiety in non-clinical populations ([Boelen, Huntjens, & van den Hout, 2014](#); [Dickson, Moberly, Hannon, & Bates, 2009](#); [Marsh, Edginton, Conway, & Loveday, 2018](#)). Findings are mixed across studies. [Boelen et al. \(2014\)](#) and [Dickson et al. \(2009\)](#) did not find a significant correlation between the specificity of future episodic simulations and anxiety symptoms in non-clinical participants. [Hallford et al. \(2019\)](#) examined a non-clinical population and found that an anxiety induction did not result in a significant change in future thinking specificity as assessed by the modified AMT. However, the authors noted that the level of anxiety produced by their induction might not have been high enough to impact future simulation. Alternatively, [Marsh et al. \(2018\)](#) investigated the simulation of specific events in a non-clinical adult population and there was a significant correlation between the specificity of future simulations and anxiety symptoms. Overall, there are mixed findings regarding the relationship between anxiety and future simulation in non-clinical populations. Mixed findings may be due to differences in the severity of anxiety symptoms between studies, but it is difficult to determine based on how anxiety levels were reported.

Valence effects using objective measures. Some studies have examined whether cue valence impacts objective episodic simulation performance in psychiatric populations. The impact of cue valence was first investigated in autobiographical memory research. Previous autobiographical memory studies used positive and negative cues to elicit autobiographical memories and they observed that patients with history of suicide attempt provided less specific autobiographical memories ([Williams & Broadbent, 1986](#); [Williams & Dritschel, 1988](#); [Williams et al., 1996](#)). The exploration of autobiographical memories elicited by emotionally valenced words was motivated by research that found congruence between mood and the valence of retrieved memories ([Blaney, 1986](#); [Isen, 1984](#), pp. 179–236). The findings in autobiographical memory research led to the examination of emotionally valenced cues and future simulation. Studies have investigated whether cue valence impacts future simulation performance differently in patients with psychiatric conditions when compared to controls. Overall, there is no clear pattern of findings, as some objective studies found that cue valence impacted episodic simulation performance in psychiatric populations when compared to controls ([Gamble et al., 2019](#); [Kleim et al., 2014](#); [Painter & Kring, 2016](#); [Parlar et al., 2016](#); [Raffard et al., 2013](#)) and others found no association ([Boulanger et al., 2013](#); [D'Argembeau et al., 2008](#); [King, Macdougall, et al., 2011](#); [King, Williams, et al., 2011](#); [Wang et al., 2017](#); [Williams et al., 1996](#); [Yang et al., 2018](#)). Findings were also variable in participants without a psychiatric diagnosis. Specifically, [Anderson et al. \(2016\)](#) and [Dickson and Bates \(2006\)](#) found cue valence impacted episodic simulation performance in individuals with dysphoria, whereas [Blix and Brennen \(2011\)](#) and [Yang et al. \(2018\)](#) found no association in individuals with a trauma history and individuals with social anhedonia respectively. In light of these findings, definitive conclusions cannot be drawn regarding the impact of cue valence on objective episodic simulation performance in psychiatric populations.

Subjective experience during episodic simulation. Studies show that subjective experience during episodic simulation is frequently altered in psychiatric populations ([Table 2](#)). The PIT is a measure most

frequently used to examine subjective experience during episodic simulation in psychiatric populations. Using the PIT, participants are presented with positively and negatively valenced future scenarios, and then they are asked to rate the vividness of the imagined scenario (described above) ([MacLeod, 1996](#); [Stöber, 2000](#)). In depression ([Morina et al., 2011](#)), dysphoria ([Boland et al., 2018](#); [Holmes, Lang, Moulds, & Steele, 2008](#)), and anxiety ([Morina et al., 2011](#)), patients rated positive future events as having lower vividness when compared to controls. In dysphoria ([Boland et al., 2018](#); [Holmes et al., 2008](#)), anxiety ([Morina et al., 2011](#); [Raune, MacLeod, & Holmes, 2005](#)), and bipolar disorder ([Di Simplicio et al., 2016](#); [Holmes et al., 2011](#)), patients rated negative future events as having higher vividness when compared to controls. Non-clinical individuals who reported higher levels of visual hallucination experiences rated negative future events as having higher imagery (i.e., higher ratings of vividness and experiencing) when compared to those with lower reported levels of visual hallucination experiences ([Aynsworth, Nemat, Collerton, Smailes, & Dudley, 2017](#)). Overall, studies using the PIT found altered subjective experience during episodic simulation in psychiatric populations. They also found that subjective experience may be moderated by cue valence, such that patients report that they more vividly experience future negative events and/or less vividly experience future positive events.

Studies using other subjective measures reported variable findings, including either diminished or enhanced subjective experience during episodic simulation. When simulating the future, patients with schizophrenia reported less subjective experience on the following indices compared to controls: sensory details ([Painter & Kring, 2016](#); [Raffard et al., 2013](#)); contextual information, self-referential information, and other-referential information, ([Raffard et al., 2013](#)); vividness and sense of pre-experiencing ([Yang et al., 2018](#)); and sense of mental time travel ([Malek et al., 2019](#)). [Raffard et al. \(2010\)](#) observed that patients with schizophrenia rated their perceived sense of presence, salience, and spatial coherence lower when compared to controls across both atemporal and future scenarios using the scene construction task. In a study by [Yang et al. \(2018\)](#), individuals with social anhedonia rated future simulations as having less sense of pre-experiencing. Individuals with dysphoria ([Anderson & Evans, 2015](#)) and patients with depression ([Hallford, Barry, et al., 2020](#)) rated future simulations as having lower vividness than controls, as well as lower on other aspects of subjective experience. [Wu et al. \(2015\)](#) instructed individuals with generalized anxiety disorder (GAD) and controls to simulate specific future events and then they repeated the simulation of future events. [Wu et al. \(2015\)](#) found that patients with GAD initially did not differ from controls when rating the amount of detail in their future simulations. However, when repeating these future simulations, individuals with GAD did not spontaneously rate simulations as increasingly detailed as seen in controls. Similar to findings using the PIT, [Winfield and Kamboj \(2010\)](#) observed that non-clinical individuals with higher levels of schizotypy rated their future simulation as having higher olfactory detail and a greater feeling of mental time travel. [Gehrt, Frostholm, Obermann, and Berntsen \(2019\)](#) found that individuals with severe health anxiety and obsessive-compulsive disorder rated future every day and anxiety-related events higher in various qualities, including mental time travel, vividness, and emotional intensity when compared to controls. Overall, these studies further support altered subjective experience during future simulation in psychiatric populations.

Some studies did not find compromised episodic simulation performance using subjective ratings. [de Oliveira et al. \(2009\)](#) asked patients with schizophrenia and controls to rate their ability to pre-experience specific future plans after describing them, and subjective ratings did not differ between groups. [Raffard et al. \(2016\)](#) asked participants to simulate self-defining future events and found that patients with schizophrenia rated their subjective experience as lower on other-referential information, but similar to controls across other subjective indices, including sensory details, contextual information, self-referential information, coherence, and perspective. [de Oliveira](#)

Table 2
Performance on selected subjective measures of future simulation in psychiatric populations.

Study	Sample	Future Simulation Measure	Cue Valence	Selected Participant Ratings	Selected Findings	Effect size
Addis et al. (2016)	Patients with current or past depressive symptoms versus controls	Modified AMT	Positive, negative, and neutral	Detail Emotional intensity	Patients with depression = controls across selected ratings Did not analyze interaction between group and cue valence	Detail: $d = -1.33$ across all cues Emotional intensity: $d = -0.57$ across all cues
Anderson et al., 2015	Participants with dysphoria versus controls	Described specific near and distant future events	No cues	Vividness	Participants with dysphoria < controls for near and distant future events	Near future: $d = -0.64$ Distant future: $d = -1.03$
Aynsworth et al. (2017)	Non-clinical individuals with higher predisposition to visual hallucinations versus lower predisposition to visual hallucinations	PIT	Positive and negative	Vividness Experiencing	Participants with higher visual hallucination experiences = lower visual hallucination experiences for positive cues across selected ratings Participants with higher visual hallucination experiences > lower visual hallucination experiences for negative cues across selected ratings	Positive cues: Vividness: $d = 0.02$ Experiencing: $d = 0.09$ Negative cues: Vividness: $d = 0.61$ Experiencing: $d = 0.59$
Boland et al. (2018)	Participants with dysphoria versus controls	Simulated future events before and after a simulation intervention (Experiment 2)	Positive and Negative	Vividness	Participants with high dysphoria < controls for positive cues Participants with high dysphoria > controls for negative cues	Pre-simulation: Positive: $d = -0.93$ Negative: $d = 1.56$ Post-simulation: Positive: $d = -0.64$ Negative: $d = 1.03$
de Oliveira et al., 2009	Patients with schizophrenia versus controls	Described specific future events related to plans for close and distant periods	Does not mention valence of cues	Ability to pre-experience ("picture") what, where, and when information	Participants with schizophrenia = controls	<u>Close periods</u> What: $d = -0.18$ Where: $d = 0.42$ When: $d = -0.35$ <u>Distant periods</u> What: $d = 0.07$ Where: $d = 0.55$ When: $d = 0.51$
Di Simplicio et al. (2016)	Participants with bipolar disorder versus controls	PIT	Positive and negative	Vividness	Participants with bipolar disorder = controls for positive cues Participants with bipolar disorder > controls for negative cues	Positive cues: $d = -0.29$ Negative cues: $d = 0.60$
Finnbogadottir et al., 2014	Non-clinical high worriers versus low worriers	Described future events	Word-cued, afraid, happy, ashamed, proud, and important	Specificity Vividness Perspective (from "my own eyes" to an observer's eyes)	High worriers > low worriers for observer perspective; High worriers = low worries for specificity and vividness No significant interaction between group and cueing	Not available
Gehrt et al. (2019)	Individuals with severe health anxiety versus controls Patients with OCD versus controls	Described specific future events	Everyday events and anxiety-related events	Mental time travel Vividness Emotional intensity	Mental time travel: Clinical groups (severe health anxiety and OCD) > controls Vividness and emotional intensity: Clinical groups (severe health anxiety and OCD) > controls; difference more pronounced when future event was anxiety-related	<u>Severe health anxiety findings:</u> Mental time travel Everyday events: $d = 0.77$ Anxiety events: $d = 1.05$ Vividness Everyday events: $d = 0.73$ Anxiety events: $d = 1.33$ Emotional intensity Everyday events: $d = 0.62$ Anxiety events: $d = 0.93$ <u>OCD findings:</u> Mental time travel Everyday events: $d = 0.45$ Anxiety events: $d = 1.04$ Vividness Everyday events: $d = 0.83$ Anxiety events: $d =$

(continued on next page)

Table 2 (continued)

Study	Sample	Future Simulation Measure	Cue Valence	Selected Participant Ratings	Selected Findings	Effect size
						1.41 Emotional intensity Everyday events: $d = 0.81$ Anxiety events: $d = 1.23$ Detail: $d = -0.77$ Emotional intensity: $d = 0.48$ $d = -0.66$
Hach et al. (2014)	Patients with depression versus controls	Modified AMT	Does not mention valence of cues	Detail Emotional intensity	Patients with depression = controls across selected ratings	
Hallford, Barry, et al. (2020)	Patients with depression versus controls	Variant of Modified AMT	Positive	Detail/Vividness	Patients with depression < controls	
Holmes et al. (2008)	Participants with dysphoria versus controls	PIT	Positive and negative	Vividness	Patients with dysphoria < controls for positive cues Participants with dysphoria > controls for negative cues	Positive cues: $d = -0.63$ Negative cues: $d = 0.53$
Holmes et al. (2011)	Participants with bipolar disorder versus controls	PIT	Positive and negative	Vividness	Patients with bipolar disorder = controls for positive cues Patients with bipolar disorder > controls for negative cues	Not available
Malek et al. (2019)	Patients with schizophrenia versus controls	Described specific future events	Does not mention valence of cues	Sense of Mental Time Travel	Patients with schizophrenia < controls	Events that were directly dated: $d = -0.87$ Events that were temporally reconstructed: $d = -0.40$
Morina et al. (2011)	Participants with depression versus controls Participants with anxiety disorders versus controls	PIT	Positive and negative	Vividness	Patients with depression < controls for positive cues. Participants with depression = controls for negative cues. Patients with anxiety < controls for positive cues. Participants with anxiety > controls for negative cues	<u>Depression findings:</u> Positive cues: $d = -1.09$ Negative cues: $d = 0.00$ <u>Anxiety findings:</u> Positive cues: $d = -1.00$ Negative cues: $d = 0.53$
Painter et al., 2016	Patients with schizophrenia or schizoaffective disorder versus controls	Described specific future events	Positive, negative, and neutral	Sensory experience	Patients with schizophrenia or schizoaffective disorder < controls No interaction between group and cue valence	Completed memory task before prospection Positive: $d = -0.29$ Negative: $d = -0.38$ Neutral: $d = -0.40$ Completed control task before prospection Positive: $d = -0.91$ Negative: $d = -0.63$ Neutral: $d = -0.74$
Raffard et al. (2010)	Patients with schizophrenia versus controls	Scene construction and future simulation task (Hassabis et al., 2007)	Does not mention valence of cues	Sense of presence Perceived salience Spatial coherence	Patients with schizophrenia < controls across atemporal and future scenarios for all selected ratings	Sense of presence: $d = -0.78$ Perceived salience: $d = -0.81$ Spatial coherence: $d = -2.81$
Raffard et al. (2013)	Patients with schizophrenia versus controls	Adaptation of scene construction and future simulation task (Hassabis et al., 2007)	Positive and negative	Sensory details Contextual information Self-referential information Other referential information	Patients with schizophrenia < controls across selected ratings No significant interaction between group and cue valence	Positive cues: Sensory details: $d = -1.35$ Contextual: $d = -1.09$ Self-referential: $d = -1.01$ Other referential: $d = -0.86$ Negative cues: Sensory details: $d = -1.11$ Contextual: $d = -0.65$ Self-referential: $d = -0.83$ Other referential: $d = -0.69$

(continued on next page)

Table 2 (continued)

Study	Sample	Future Simulation Measure	Cue Valence	Selected Participant Ratings	Selected Findings	Effect size
Raffard et al. (2016)	Patients with schizophrenia versus controls	Described self-defining future events	None	Sensory details Contextual information Self-referential information Other-referential information Coherence Perspective	Participants with schizophrenia < other-referential information Participants with schizophrenia = controls on all other ratings	Sensory details: d = -0.20 Contextual: d = -0.21 Self-referential: d = -0.26 Other-referential: d = -0.61 Coherence: d = -0.26 Perspective: d = -0.08 d = 0.78
Raune et al. (2005) Winfield et al., 2010	Participants with anxiety versus controls Non-clinical participants with higher levels of schizotypy versus lower levels of schizotypy	Described future negative events Imagined specific future events	Negative No cues	Vividness Olfactory detail Subjective time travel	Participants with anxiety > controls Individuals with higher levels of schizotypy > lower levels of schizotypy for olfactory detail and subjective time travel	Olfactory detail: d = 0.57 Mental time travel: d = 1.07
Wu et al. (2015)	Patients with generalized anxiety disorder versus controls	Simulated specific future events	Positive, negative, and neutral	Detail	Patients with GAD = controls initially; When simulations were repeated, patients with GAD did not rate simulations as increasingly detailed as seen in controls No interaction between group and cue valence	First simulation: Positive Cues: d = 0.24 Negative Cues: d = 0.48 Neutral Cues: d = 0.17 Fourth simulation: Positive Cues: -0.26 Negative Cues: -0.25 Neutral Cues: -0.38
Yang et al. (2018)	Patients with schizophrenia versus controls Individuals with social anhedonia versus controls	Described specific future events	Positive, negative, and neutral	Vividness Sense of pre-experiencing	Patients with schizophrenia < controls for vividness and sense of pre-experiencing Individuals with social anhedonia < controls for sense of pre-experiencing; Individuals with social anhedonia = controls for vividness No significant interaction between group and cue valence	<u>Schizophrenia findings:</u> Vividness Positive: d = -0.69 Negative: d = -0.42 Neutral: d = -0.89 Sense of pre-experiencing Positive: d = -0.60 Negative: d = -0.68 Neutral: d = -0.63 <u>Social anhedonia findings:</u> Vividness Positive: d = -0.48 Negative: d = -0.19 Neutral: d = -0.29 Sense of pre-experiencing Positive: d = -0.65 Negative: d = -0.46 Neutral: d = -0.39

Note. Adapted AI task = Adapted Autobiographical Interview. Modified AMT = modified Autobiographical Memory Test. PIT = Prospective Imagery Task. SCEFT = Sentence Completion for Events in the Future Test. "Not available" indicates that information was not provided to calculate effect size(s). Cohen's d effect sizes were calculated using means and pooled standard deviations. The following formula was used: $d = (M_1 - M_2) / SD$ pooled.

et al. (2009) and Raffard et al. (2016) may have had different findings regarding subjective experience than other studies in schizophrenia due to methodological differences, such as asking participants to simulate future plans or self-defining future events, respectively.

Finnbogadóttir and Berntsen (2014) found that non-clinical high worriers rated their perspective when simulating future events as more "observer-like" when compared to low worriers, but did not differ on other subjective ratings, such as specificity and vividness. These findings differed from Wu et al. (2015) in their study of patients with GAD, as patients with GAD demonstrated smaller increases in ratings of detail

after repeating future simulations when compared to controls. It is possible that Finnbogadóttir and Berntsen (2014) would have found differences on specificity and vividness ratings if participants repeated their simulations of the future. Finnbogadóttir and Berntsen (2014) also examined worry in a non-clinical population, whereas Wu et al. (2015) examined individuals diagnosed with GAD. A few studies did not find subjective differences between patients with depression and controls. Addis et al. (2016) and Hach et al. (2014) observed that patients with depression subjectively rated the level of detail and emotional intensity similarly to controls when simulating the future. It is unclear why Addis

et al. (2016) and Hach et al. (2014) reported different findings compared to other studies with subjective ratings in individuals with dysphoria (Anderson & Evans, 2015; Boland et al., 2018; Holmes et al., 2008) and depression (Morina et al., 2011). While there is some variability in the literature, most studies found that subjective experience was compromised during future simulation in psychiatric populations.

Valence effects using subjective measures. As described earlier, studies using the PIT or a similar task in patients with depression (Morina et al., 2011), dysphoria (Boland et al., 2018; Holmes et al., 2008), anxiety (Morina et al., 2011), bipolar disorder (Di Simplicio et al., 2016; Holmes et al., 2011), and non-clinical individuals with a higher predisposition to visual hallucinations (Aynsworth et al., 2017) found that the valence of future scenarios impacted ratings of their subjective experience when compared to controls. Most other studies using alternative subjective measures did not find that cue valence impacted subjective experience during episodic simulation in patients with schizophrenia (Painter & Krings, 2016; Raffard et al., 2013; Yang et al., 2018) and GAD (Wu et al., 2015) when compared to controls. However, findings by Gehrt et al. (2019) suggest that the difference in subjective ratings (such as vividness and emotional intensity) between the clinical groups (severe health anxiety and OCD) and controls is more pronounced when the future event was anxiety-related. Though findings are variable, valence may moderate subjective experience in psychiatric populations.

Summary. Episodic simulation is altered in a range of psychiatric populations. Studies using objective measures suggest that participants with psychiatric conditions and elevated psychiatric symptoms provide fewer internal details or specific details during episodic simulation, including patients with depression, dysphoria, suicidality, PTSD, schizophrenia, and bipolar disorder, as well as individuals with social anhedonia. Some research suggests that subjective experience during episodic simulation is also altered in psychiatric populations and individuals with elevated psychiatric symptoms, including patients with depression, dysphoria, schizophrenia, bipolar disorder, OCD, anxiety, individuals with higher reported levels of visual hallucination experiences, individuals with higher levels of schizotypy, and individuals with social anhedonia. These psychiatric populations rate their subjective experience during episodic simulation as either diminished or increased during episodic simulation, which may also be moderated by cue valence. However, there are some studies finding intact subjective experience in psychiatric populations.

Given evidence for impaired or altered episodic simulation in psychiatric populations, it is important to explore the factors that may contribute to episodic simulation performance in these groups. There are various cognitive mechanisms that may contribute to episodic simulation impairment in psychiatric conditions, including episodic memory, scene construction, mental imagery, components of the CaRFAX model (Williams, 2006; Williams et al., 2007) (i.e., functional avoidance, rumination, and executive functioning), and narrative style.

3. Cognitive mechanisms of compromised episodic simulation in psychiatric populations

3.1. Episodic memory retrieval

Substantial evidence suggests that episodic memory, specifically episodic retrieval, is closely related to the ability to simulate the future (Schacter & Addis, 2007, 2020, pp. 111–131; Schacter, Addis, & Buckner, 2007). Evidence supporting the role of the episodic retrieval in future simulation includes the overlap in cognitive and neural processes that have been documented when people remember the past and imagine the future (Schacter, 2019; Schacter et al., 2008, 2012). Specifically, past and future thinking share a core neural network and phenomenological characteristics, and patients with neurological and psychiatric conditions have impairments across past and future thinking (Addis & Schacter, 2012; Benoit & Schacter, 2015). Based on these and

other findings, Schacter and Addis proposed the constructive episodic simulation hypothesis (Schacter & Addis, 2007, 2020, pp. 111–131; Schacter et al., 2007). This hypothesis states that past and future thinking rely on the episodic memory retrieval, which enables the ability to simulate the future by supporting flexible recombination of details from different past experiences into simulations of a novel future event. Because the future is rarely identical to the past, flexible recombination is viewed as an adaptive process, but the same flexible retrieval process can also lead to memory errors when elements of past experiences are miscombined (for relevant evidence, see Carpenter & Schacter, 2017, 2018).

Researchers have increasingly investigated the relationship between episodic memory and episodic simulation in psychiatric populations. Much of this work suggests that episodic memory may be a mechanism contributing to future simulation impairment in certain psychiatric populations. Specifically, individuals with psychiatric conditions may have deficits in retrieving and/or recombining episodic details when remembering the past and simulating the future. Studies in psychiatric populations have found a positive relationship between episodic memory (i.e., retrieval of a specific autobiographical memory) and future simulation. Using the AMT, moderate to large positive correlations were observed between specificity of autobiographical remembering and future simulation in patients with depression (Addis et al., 2016; Belcher & Kangas, 2014), patients with history of suicide attempt (Williams et al., 1996), PTSD (Brown et al., 2013), and schizophrenia (D'Argembeau et al., 2008). These studies used neutral cues (Brown et al., 2013) or found significant positive correlations across all cues regardless of valence (Addis et al., 2016; Belcher & Kangas, 2014; D'Argembeau et al., 2008; Williams et al., 1996). Using the adapted AI task with neutral cues, significant positive correlations were found between internal details (i.e., episodic details tied to a specific time and place) when remembering past events and simulating future events in patients with depression ($r = 0.68, p < .001$) (McFarland, Primosch, Maxson, & Stewart, 2017) and PTSD ($r = 0.80, p = .001$) (Brown et al., 2014). Chen et al. (2016) asked participants to remember autobiographical events (Sentence Completion for Events in the Past; SCEPT) and simulate possible future events (SCEFT). Chen et al. (2016) found a moderate positive correlation ($r = 0.42, p < .001$) between the specificity of remembering past events and simulating future events across patients with schizophrenia and controls.

A few studies produced alternative findings when examining the relationship between autobiographical memory and future simulation. Blix and Brennen (2011) examined the correlation between specificity of the episodic remembering and future simulation using the AMT across participants with a trauma history (without a clinical diagnosis) and controls, and found that the relationship differed depending on cue valence. Specifically, there was a positive relationship between specificity of autobiographical remembering and future simulation for positive cue words ($r = .42, p < .01$), a negative correlation for neutral cue words ($r = -0.31, p < .05$), and no significant correlation for negative cue words ($r = 0.03, p = .83$). Blix and Brennen (2011) noted that their findings (i.e., negative correlation for neutral cue words and a lack of a significant correlation for negative cue words) differed from other studies that found a positive relationship between autobiographical remembering and future simulation (e.g., D'Argembeau et al., 2008; Williams et al., 1996). Blix and Brennen (2011) stated that their findings may be due to methodological differences, such as their task being in a computerized format rather than an interview format, providing reminders to retrieve a specific event with each cue word, and using different cue words in their study. One study in bipolar patients required patients to retrieve specific past and future autobiographical events using the AMT and found that specificity of autobiographical remembering and future simulation was not significantly correlated ($r = 0.19, p = .43$) (Boulanger et al., 2013). There is no evidence thus far examining the relationship between autobiographical remembering and future episodic simulation in anxiety disorders. Overall, most research in

psychiatric populations suggests that there is a positive association between remembering the past and imagining the future.

The role of episodic memory in future simulation has also been supported through studies that experimentally manipulate the retrieval of episodic details using an *episodic specificity induction* (ESI; for review, see Schacter & Madore, 2016), which involves brief training in recalling episodic details of a recent event. The ESI boosted performance on subsequent tasks that required healthy young and older adults to remember past experiences and imagine future experiences by increasing internal (i.e., episodic) details, while having no effect on external (i.e., semantic) details (Madore, Gaesser, & Schacter, 2014). This enhancement was selective: ESI had no effect in young or old adults on a picture description task that does not draw on episodic retrieval. The ESI has also improved participant performance on other tasks that recruit episodic retrieval, including social problem-solving (Jing et al., 2016; Madore & Schacter, 2014) and divergent creative thinking in both young and old adults (Madore, Addis, & Schacter, 2015; Madore, Jing, & Schacter, 2016). These studies support the role of episodic retrieval in future imagining, as well as other cognitive processes that rely on episodic retrieval.

One study using the ESI supports episodic retrieval as a cognitive mechanism contributing to future simulation in depression. McFarland et al. (2017) found that the ESI resulted in increased generation of internal details during the simulation of future events in individuals with depression. The ESI also enhanced performance on memory and problem-solving tasks, which are also tasks that rely on episodic retrieval. This study supports the role of episodic retrieval in future episodic simulation in a psychiatric population. Future work could expand the investigation of episodic retrieval in episodic simulation to other psychiatric populations.

Overall, the evidence indicates that episodic retrieval is a likely mechanism of future simulation impairment in psychiatric populations. Thus, individuals with psychiatric conditions may have difficulty imagining the future as a consequence of difficulty retrieving and recombining episodic details. This conclusion is supported by research that found overlap between episodic memory and simulation in various psychiatric populations, and improved future simulation performance in patients with depression after the experimental manipulation of episodic retrieval. The relevant research has focused on objective measures of future simulation. As a result, it is unclear how episodic retrieval may impact subjective experience during future simulation in patients with psychiatric conditions.

3.2. Scene construction

Scene construction was defined by Hassabis and Maguire (2007, p. 299) as “the process of mentally generating and maintaining a complex and coherent scene or event.” Researchers have proposed that scene construction is a cognitive mechanism that supports both memory and imagination (Hassabis & Maguire, 2007, 2009; Mullally & Maguire, 2014). Theoretically, patients with psychiatric conditions may not be able to effectively simulate the future if they cannot construct a spatially coherent scene. However, scene construction has been minimally investigated in psychiatric populations. Raffard et al. (2010) asked participants with schizophrenia and controls to simulate atemporal and future scenarios using the scene construction task (Hassabis et al., 2007), which includes both subjective and objective ratings to assess the richness of descriptions. Raffard et al. (2010) found that individuals with schizophrenia were impaired on atemporal scenarios (i.e., scene construction) and future simulation using the scene construction task (Hassabis et al., 2007). Specifically, patients with schizophrenia provided simulations characterized by poorer quality and fewer sensory and spatial details when compared to controls. Additionally, patients with schizophrenia rated their perceived sense of presence, salience, and spatial coherence lower when compared to controls. Some researchers have proposed that impairment across both simulation of atemporal

scenes and future simulation suggests that impairment in episodic simulation tasks may be due to deficits in scene construction (Hassabis & Maguire, 2007, 2009; Palombo, Hayes, Peterson, Keane, & Verfaellie, 2016). However, impaired performance across scene construction and episodic simulation tasks could be due to a common cognitive mechanism, such as impaired episodic retrieval (Schacter & Madore, 2016), or perhaps a subcomponent of episodic retrieval referred to as *event construction* (see Romero & Moscovitch, 2012). Event construction is similar to scene construction in that it refers to the mental assembly of people, places, objects, and actions that constitute an event, except that event construction, unlike scene construction, does not place special emphasis on the spatial coherence of a constructed event. Thus, this may explain why patients with schizophrenia in Raffard et al. (2010) were impaired on both scene construction and future simulation tasks, because both cognitive tasks rely on event construction processes that are compromised in schizophrenia.

Minimal research has investigated scene construction as a mechanism of episodic simulation impairment in psychiatric conditions and is thus far inconclusive. Limited findings tentatively support that the idea that patients with schizophrenia have difficulty producing detailed and salient future simulations as a result of poor mental construction of a spatially coherent scene. However, impairment across both scene construction and episodic simulation tasks may be attributable to a common cognitive mechanism, such as the event construction component of episodic retrieval.

3.3. Mental imagery

Mental imagery has been defined as the simulation or re-creation of a perceptual experience (Heyes, & Holmes, 2013; Kosslyn, Ganis, & Thompson, 2001; Pearson, Deepro, Wallace-Hadrill, Burnett, Pearson, Naselaris, Holmes, & Kosslyn, 2015). Holmes and Mathews (2010) stated that mental imagery involves more than mental images and “can involve multiple sensory modalities, including bodily sensations and feelings, and can represent complex actions and events that change over time.” Mental imagery can be voluntary or involuntary (Holmes & Mathews, 2010; Pearson, Deepro, Wallace-Hadrill, Burnett Heyes, & Holmes, 2013) and can be neutral or emotionally-valenced (Holmes & Mathews, 2010). Mental imagery has been conceptualized and examined in many ways in psychiatric populations (for an in-depth review, see Pearson et al., 2013). Here we focus on four basic cognitive aspects of mental imagery that were proposed by Kosslyn and colleagues, which include image generation, maintenance, inspection, and transformation/manipulation (Kosslyn, 1981, 1995, pp. 267–296). These processes provide the cognitive building blocks that enable the ability to engage in mental imagery. Research has investigated the basic cognitive aspects of mental imagery in psychiatric populations. Findings from these studies, as discussed below, may clarify whether these abilities could contribute to episodic simulation impairment in psychiatric populations. However, only one study has examined both the cognitive aspects of mental imagery and episodic simulation (Di Simplicio et al., 2016).

Image generation. Image generation is “the ability to form visual images” (Dror & Kosslyn, 1994, p. 90). Most studies suggest that patients with psychiatric conditions have generally intact image generation accuracy (e.g., accurately generating previously learned images in space) (e.g., Aleman, de Haan, & Kahn, 2005; Di Simplicio et al., 2016; Zarrinpar, Deldin, & Kosslyn, 2006), but they have slower response times when generating an image (e.g., Amir, Najmi, & Morrison, 2012; Cocude, Charlot, & Denis, 1997; Morrison, Amir, & Taylor, 2011; Zarrinpar et al., 2006). It is possible that patients with psychiatric conditions exhibit impaired episodic simulation because they are slower at generating images. Alternatively, the ability to accurately generate an image may depend on the familiarity of stimuli and working memory (Mathews, Collins, Thakkar, & Park, 2014), which may be relevant to simulation of novel future scenarios. However, further support for these

hypotheses are needed.

Image maintenance. Image maintenance is “the ability to retain images over time.” (Dror & Kosslyn, 1994, p. 90). Image maintenance tasks tend to involve showing participants an image and, after a delay, participants are asked to recall details or the location of the image. Overall, patients with schizophrenia showed the most consistent deficits in image maintenance (e.g., Fleming et al., 1997; Lee, Folley, Gore, & Park, 2008; Park & Holzman, 1992; Park, Puschel, Sauter, Rentsch, & Hell, 1999; Piskulic, Olver, Norman, & Maruff, 2007). Based on these findings, one could hypothesize that patients with schizophrenia are impaired at episodic simulation due to difficulty maintaining mental images.

Patients with anxiety, bipolar disorder, and depression exhibit impairments in visuospatial working memory, which may be relevant to the literature on image maintenance (see reviews that discuss these deficits in anxiety (Moran, 2016), bipolar disorder (Soraggi-Frez, Santos, Albuquerque, & Malloy-Diniz, 2017), and depression (Baune, Fuhr, Air, & Hering, 2014; Rock, Roiser, Riedel, & Blackwell, 2014; Snyder, 2013)). Research has been variable in patients with bipolar disorder (e.g., Di Simplicio et al., 2016; Pan, Hsieh, & Liu, 2011; Park & Holzman, 1992), so it is unclear if difficulty maintaining a mental image contributes to episodic simulation impairment in this population. Cocude et al. (1997) suggested that patients with depression can maintain images a similar length of time as controls. Future research could examine which aspects of image maintenance are impaired in depression, which could determine its relevance for their ability to simulate the future.

Image inspection. Image inspection involves interpreting a characteristic of a generated mental image (Dror & Kosslyn, 1994; Pearson et al., 2013). Image inspection findings are variable in patients with schizophrenia (e.g., Aleman, Bocker, Hijman, de Haan, & Kahn, 2003; Aleman et al., 2005; David & Cutting, 1993), and minimal research has been conducted in other populations such as social phobia (e.g., Amir et al., 2012) and bipolar disorder (e.g., Di Simplicio et al., 2016). Thus, it is unclear whether difficulty inspecting aspects of mental images contributes to episodic simulation impairment in psychiatric populations.

Image transformation and manipulation. Image transformation and manipulation refers to the ability to rotate or otherwise alter an imagined pattern (Dror & Kosslyn, 1994, p. 90). An example task includes presenting hands at different orientations and participants are asked to judge whether the hand is the right or left hand (Chen et al., 2013, 2014; de Vignemont et al., 2006; Mazhari, Tabrizi, & Nejad, 2015; Parsons, 1987). Another task involves presenting letters or numbers at different orientations and participants are asked to decide if the letter or number is in the correct orientation or a mirror image (Chen et al., 2013, 2014; de Vignemont et al., 2006; Rogers et al., 2002).

Slower speed during image transformation was found across multiple studies in patients with schizophrenia (e.g., de Vignemont et al., 2006; Jiménez, Mancini-Marie, Lakis, Rinaldi, & Mendrek, 2010; Knight, Manoach, Elliott, & Hershenson, 2000; Mazhari et al., 2015), as well as patients with depression (e.g., Chen et al., 2013; Chen et al., 2014; Rogers et al., 2002; Zarrinpar et al., 2006) and individuals with higher trait anxiety (Kaltner & Jansen, 2014). Speed of image transformation and manipulation was found to be intact in patients with bipolar disorder (Di Simplicio et al., 2016). One hypothesis is that certain psychiatric populations have impaired episodic simulation because they are slower at transforming and manipulating images.

Mental imagery and episodic simulation. One study has investigated both the basic cognitive processes of mental imagery (i.e., image generation, maintenance, inspection, and transformation/manipulation) and episodic simulation of future events using the PIT in patients with bipolar disorder (Di Simplicio et al., 2016). Di Simplicio and colleagues found that patients with bipolar disorder largely did not exhibit impairments in cognitive aspects of mental imagery when compared to controls. However, patients with bipolar disorder reported altered subjective experience during future simulation, as they rated negative future events as more vivid than controls. Notably, these authors did not

examine the relationship between the basic generative aspects of mental imagery and episodic simulation.

The finding that basic mental imagery was intact suggests that basic mental imagery impairment (i.e., difficulty generating, maintaining, inspecting, or transforming/manipulating a mental image) probably does not explain their altered subjective future thinking. This finding may not be surprising, given previous work did not find consistent deficits in basic mental imagery processes in patients with bipolar disorder. Additionally, there is currently not a theoretical basis for understanding how basic mental imagery abilities could contribute to altered subjective experience during future simulation, such as enhanced vividness for future negative events and/or diminished vividness for positive events. Impaired basic mental imagery processes may lead to difficulty retrieving episodic details when simulating the future (i.e., performance on objectively measured future simulation tasks), but this possibility has not been examined.

Further research on mental imagery and future simulation is needed. Mental imagery may contribute to future simulation in other populations, such as patients with schizophrenia, and could be examined in future research. As noted by Pearson et al. (2013) in their comprehensive review of mental imagery in psychiatric populations, future research should take generalized cognitive deficits into account, such as slowed processing speed and executive dysfunction.

3.4. *CaRFAX: Rumination, functional avoidance, and executive dysfunction*

The CaRFAX model (Williams, 2006; Williams et al., 2007) enumerates cognitive mechanisms of overgeneral (i.e., less specific) memory in psychiatric populations, including rumination, functional avoidance, and executive dysfunction. Some researchers have examined whether these same cognitive mechanisms may explain impairment in future episodic simulation in psychiatric populations. Components of the CaRFAX model have been examined mainly in studies using objective measures of episodic simulation.

Rumination. Rumination is defined as repetitive and passive thinking about one’s negative mood states and the possible causes and consequences of one’s negative mood (Nolen-Hoeksema, 1991). According to the CaRFAX model, rumination results in overgeneral memory because simulating the past triggers the analysis of self-relevant information (Williams, 2006). Theoretically, rumination may also interfere with simulating detailed future events because one’s thoughts are focused on their negative mood.

Rumination has been investigated in a few studies examining future simulation in psychiatric populations. Addis et al. (2016) examined the simulation of specific and plausible future events using the modified AMT and self-reported rumination using the Rumination Subscale of the Rumination and Reflection Scale (RRS) (Trapnell & Campbell, 1999). The Rumination Subscale of the RRS assesses the brooding style of rumination by asking participants to rate the level of agreement with items on a 5-point scale (1 = strongly disagree to 5 = strongly agree). An example item is “I always seem to be “re-hashing” in my mind recent things I’ve said or done.” Addis et al. (2016) did not find a significant relationship between rumination and the proportion of specific future events in patients with depression. Using the same rumination and episodic simulation measures, Hach et al. (2014) found elevated rumination and a lower proportion of specific events during episodic simulation in depressed individuals, though they did not examine the relationship between the two variables. Gehrt et al. (2019) asked clinical participants (OCD and health related anxiety) and controls to imagine every day and anxiety related future events. When compared to controls, clinical participants rated their experience higher on various qualities including rumination (“When the event comes to mind I usually keep thinking about it”), vividness, mental time travel, and emotional intensity. Because Gehrt et al. (2019) did not examine the relationship between rumination and vividness ratings, it is unclear if they were

associated. Thus, findings in clinical populations currently do not provide adequate evidence for the role of rumination in the alteration of future simulations.

Studies completed in non-clinical populations produced variable results. Sansom-Daly, Bryant, Cohn, and Wakefield (2014) experimentally manipulated rumination by randomly assigning non-clinical participants to a rumination condition or a control condition. They found that the rumination condition resulted in generation of less specific future events when the events were related to illness concerns. One study found that more frequently engaging in ruminative thought patterns when sad or down was related to a lower number of specific future events in response neutral words (Marsh et al., 2018). Alternatively, Belcher and Kangas (2015) did not find a relationship between rumination (i.e., reflection, brooding, and depression related) and the proportion of specific future events using the modified AMT. Hallford et al. (2019) instructed a non-clinical population to rate their rumination on a visual analogue scale ("Indicate how much you are mulling things over in your head right now that have happened to you in the past"). Hallford et al. (2019) found that rumination was not significantly associated with future specificity, as assessed by the AMT. Similarly, Robinaugh, Lubin, Babcic, and McNally (2013) did not find a significant relationship between the tendency to engage in perseverative and repetitive negative thought and the specificity of future simulations using the SCEFT. Given variable findings, it is unclear whether rumination interferes with the ability to simulate detailed future events in psychiatric and non-clinical populations. It is also unclear how and if rumination contributes to altered subjective experience during future simulation. There is currently insufficient evidence to suggest that rumination is a mechanism of episodic simulation, though few studies have investigated this relationship.

Future work could examine the role of attention, working memory, and inhibition in the relationship between rumination and future simulation. Some research suggests that rumination results from difficulty inhibiting negative information held in working memory (Joormann, 2010), impaired attentional disengagement from persistent negative self-referent information (Koster, De Lissnyder, Derakshan, & De Raedt, 2011), and a narrow attentional scope (Whitmer & Gotlib, 2013). It is possible that individuals with psychiatric conditions may also have difficulty retrieving detailed future simulations because they cannot inhibit or disengage from negative self-information, or they cannot broaden their attentional scope to relevant details. This idea may also explain why some psychiatric populations have difficulty experiencing future positive events in a vivid manner.

Functional avoidance. According to the CaRFAX model, functional avoidance occurs when individuals engage in the retrieval of overgeneral memories to regulate emotion, given that retrieving specific memories results in greater affective disturbance (Williams, 2006). Individuals may also retrieve overgeneral future simulations to regulate their emotion, especially in psychiatric populations. However, there is currently little evidence to suggest that avoidance contributes to future simulation deficits in psychiatric populations. In patients with depression, Addis et al. (2016) did not find a significant relationship between avoidance (using the Cognitive and Behavioral Avoidance Scale (CBAS); Ottenbreit & Dobson, 2004) and the specificity of future simulation (using the modified AMT). Belcher and Kangas (2014) reported similar results: they found no relationship between the specificity of future episodic simulations using the modified AMT and the specificity of avoidance goals in a depressed sample. Hach et al. (2014) found higher avoidance and impaired specificity of future events using the modified AMT in individuals with depression when compared to control subjects, but the relationship between the two variables was not examined. Gehrt et al. (2019) asked clinical participants (OCD and severe health-related anxiety) and controls to imagine every day and anxiety related future events. The clinical participants rated their experience higher on various qualities, including avoidance ("When the event comes to mind I usually try and push it away from my mind"), vividness, mental time travel, and

emotional intensity. However, they did not examine the relationship between vividness and avoidance ratings. Overall, most evidence suggests that avoidance is not a mechanism that contributes to episodic simulation impairment in psychiatric populations. Specifically, avoidance of affective disturbance may not be the reason that patients with psychiatric conditions report future simulations with less episodic detail. Future work could examine whether avoidance has a role in altered subjective experience during future simulation.

Executive functioning. The CaRFAX model suggests that deficits in executive control or capacity can interfere with the ability to engage in retrieval of a specific past event (Williams, 2006). Executive dysfunction may also interfere with the ability to retrieve specific future events. The relationship between executive functioning and future simulation in psychiatric populations depends on how executive functioning is measured. Speeded word generation from a particular class (i.e., phonemic fluency) was not significantly related to future simulation in patients with depression (Addis et al., 2016; Parlar et al., 2016), PTSD (Brown et al., 2014), schizophrenia (D'Argembeau et al., 2008; Raffard et al., 2016), and bipolar disorder (Boulanger et al., 2013). Boulanger et al. (2013) did not find a relationship between inhibition using the Stroop task and the generation of specific future events using the modified AMT in patients with bipolar disorder. Other studies failed to find a significant relationship between future simulation and task switching (Addis et al., 2016; Parlar et al., 2016) or planning (Addis et al., 2016) in patients with depression. Working memory was not significantly related to future simulation in patients with depression (Addis et al., 2016), and bipolar disorder (Boulanger et al., 2013), though there were variable findings in schizophrenia (Yang et al., 2018, 2019). By contrast, other measures of executive functioning have been significantly associated with future simulation. Addis et al. (2016) found a relationship between strategic retrieval (i.e., CVLT-II semantic clustering) and the specificity of future simulation using the AMT in depression. Parlar et al. (2016) found a relationship between executive functioning (cognitive flexibility as measured by the Wisconsin Card Sorting Task and sustained attention using the Continuous Performance Test) and future simulation (i.e., internal details using the adapted AI task) in patients with depression and history of trauma.

Overall, the evidence thus suggests that certain aspects of executive functioning may be related to episodic simulation in psychiatric conditions. Specifically, deficits in strategic retrieval, cognitive flexibility, and sustained attention may contribute to difficulty simulating detailed future events. Future work is needed to examine if these factors also contribute to altered subjective experience in psychiatric populations.

Summary. Overall, there is inconsistent support for components of the CaRFAX model as candidate cognitive processes that influence episodic simulation in psychiatric populations. Variable results were found for rumination and there was a lack of significant results for avoidance. One possible reason for the lack of significant findings for rumination and avoidance is that these effects may depend on the emotional valence of cues, and most of the studies either did not include emotionally valenced cues (Hach et al., 2014; Marsh et al., 2018; Robinaugh et al., 2013) or examined the relationship between episodic simulation and the CaRFAX factors (rumination and avoidance) across all cues regardless of valence (Addis et al., 2016; Belcher & Kangas, 2014, 2015; Hallford et al., 2019). The findings for rumination may be attributable to the severity of clinical symptoms, as multiple studies were conducted in non-clinical populations (Belcher & Kangas, 2015; Hallford et al., 2019; Marsh et al., 2018; Robinaugh et al., 2013; Sansom-Daly et al., 2014). However, Sansom-Daly et al. (2014) and Marsh et al. (2018) reported significant findings for rumination in a non-clinical samples, and Marsh et al. (2018) used neutral cues. Specific aspects of executive functioning may impact episodic simulation in psychiatric populations, such as strategic retrieval, cognitive flexibility, and sustained attention, though evidence is limited.

3.5. Narrative style

Narrative style refers to the manner in which people talk about their experiences and the communicative goals that they seek to achieve (e.g., Labouvie-Vief & Blanchard-Fields, 1982). Thus, any general change in how one communicates about their experience may impact future simulation. Narrative style has been investigated in older adults as a potential cognitive mechanism contributing age-related changes in episodic simulation (Gaesser, Sacchetti, Addis, & Schacter, 2011; Madore et al., 2014; reviewed by; Schacter, Devitt, & Addis, 2018; Schacter, Gaesser, & Addis, 2013). Gaesser et al. (2011) investigated performance across memory, future episodic simulation, and picture description tasks in older adults. They found that older adults showed reduced internal details and increased external details across memory, episodic simulation, and picture description tasks when compared to young adults (on picture description tasks, internal details were defined as details that were physically present in the picture, e.g., details concerning physically present objects, people, actions, places). Gaesser et al. (2011) argued that picture description does not rely on episodic retrieval, therefore concluded that non-episodic factors contributed to the older adults' impaired performance across all three tasks, such as age-related changes in narrative style. For example, older adults experience increased off-topic speech, disinhibition, and different communication goals when compared to younger adults (Arbuckle & Gold, 1993; Labouvie-Vief & Blanchard-Fields, 1982; Trunk & Abrams, 2009). Such factors can influence performance on the modified AI task used to assess remembered past and imagined future experiences, thus must be considered when impairments in older adults or patient populations are observed on these and related tasks. However, subsequent research using the ESI showed that episodic retrieval in young and old adults can be distinguished from the influence of narrative style (Madore et al., 2014).

Narrative style may be a factor that impacts episodic simulation performance in psychiatric conditions. Narrative style seems especially relevant for patients with depression, bipolar disorder, and schizophrenia. Psychomotor retardation is a symptom that is characteristic of depression, and has been found to result in slowed speech (Schrijvers, Hulstijn, & Sabbe, 2008; Sobin & Sackeim, 1997). During periods of mania or hypomania, patients with bipolar disorder present with a "flight of ideas" and pressured speech (Anderson, Haddad, & Scott, 2012; Cassidy, Murry, Forest, & Carroll, 1998). Patients with schizophrenia present with disorganized speech, which presents as speech being tangential or having loose associations (Covington et al., 2005; Roche, Creed, MacMahon, Brennan, & Clarke, 2014; Schultz & Andreasen, 1999). Patients with schizophrenia also present with poverty of speech (Foussias & Remington, 2008; Schultz & Andreasen, 1999). Theoretically, if patients' thought content is slowed, pressured, or disorganized, it may interfere with retrieving future episodic details. As a result, patients may report more off-topic and non-specific details when simulating the future rather than rich episodic details, or they may experience future simulations with less vividness. Based on the findings from Gaesser et al. (2011), narrative style may not only impact future simulation in patients with psychiatric conditions, but also their descriptions of their current and past experiences.

However, narrative style has been studied infrequently in psychiatric conditions. A few studies have found impaired "coherence" when communicating future descriptions in schizophrenia, which possibly could reflect the impact of disorganized speech on episodic simulation performance. Huddy et al. (2016) found that patients with schizophrenia and schizoaffective disorder communicate with less coherence, as objectively rated by examiners, when simulating hypothetical scenarios when compared to controls. Painter and Kring (2016) asked participants to generate specific future events, and experimenters rated the clarity of episodic simulation in patients with schizophrenia and schizoaffective disorder. A narrative was rated "clear" if it was organized and easy to understand, "moderately clear" if the narrative was

relatively understandable, but at times the content was difficult to understand or follow, and "unclear" if the narrative was difficult to follow or disorganized. Painter and Kring (2016) found that individuals with schizophrenia and schizoaffective disorder had episodic simulations that were rated as having lower clarity than controls when responding to negative cues. Anderson and Evans (2015) found individuals with dysphoria rated their experience while simulating the future as having lower coherence when compared to controls (i.e., order of events is less clear and tells less of a coherent story).

Overall, studies have found compromised clarity or coherence of future simulations in psychiatric populations. These findings provide preliminary evidence that narrative style may contribute to poor simulation in psychiatric populations. However, no studies have directly examined the relationship between these two constructs in psychiatric populations, so the impact of narrative style on future simulation is still an open question. Future work could directly examine the relationship between disorganized speech and episodic simulation in schizophrenic patients, and could also examine additional factors that may influence narrative style in psychiatric patients, including psychomotor retardation, pressured speech, or paucity of speech. This research could help determine if narrative style accounts for altered episodic simulation performance in psychiatric conditions, or if their performance is better accounted for by other cognitive mechanisms.

4. Summary and conclusion

This paper reviewed studies that investigated episodic simulation performance in psychiatric populations and the cognitive processes that may contribute to their ability to engage in episodic simulation. Studies using objective measures of episodic simulation have found that patients with psychiatric conditions provide future simulations with fewer specific details and fewer details tied to a specific time and place. Some evidence also suggests that patients with psychiatric conditions have altered subjective experiences during future simulation, reporting their subjective experiences as diminished or enhanced compared to controls.

Various cognitive processes have been proposed as potential mechanisms of episodic simulation impairment in psychiatric conditions, including episodic retrieval, scene construction, mental imagery, elements of the CARFAX model (avoidance, rumination, and executive functioning), and narrative style. Based on the current literature, evidence suggests that episodic retrieval is a likely mechanism of episodic simulation impairment in certain psychiatric populations. There is less evidence available concerning the closely related construct of scene construction, which emphasizes spatial aspects of imagined events. Future research should more closely examine whether patients with psychiatric conditions exhibit impairments in episodic simulation because of difficulty generating spatial relations when constructing imagined scenes, or because of problems recombining and integrating both spatial and non-spatial aspects of event representations. There is as yet limited evidence that deficits in mental imagery (i.e., image generation, image maintenance, image inspection, and image transformation/manipulation) contribute to episodic simulation deficits in psychiatric populations. However, both mental imagery and episodic simulation have been investigated together only in patients with bipolar disorder. Thus, further research is needed to determine whether mental imagery contributes to episodic simulation in other psychiatric populations. For example, patients with schizophrenia present with impairments in image maintenance, which may be relevant for future simulation.

Certain aspects of the CARFAX model, namely avoidance and rumination, have so far received limited support as mechanisms of episodic simulation impairment in psychiatric disease. However, problems with aspects of executive functioning may contribute to episodic simulation performance in psychiatric populations, such as strategic retrieval, cognitive flexibility, and sustained attention. Lastly, narrative style may impact the ability to clearly and coherently communicate future simulations in patients with psychiatric conditions, but much more research

on this topic is needed. Taken together, research to-date provides initial insights into the cognitive factors that may underlie episodic simulation impairment in psychiatric populations, but it seems likely that multiple cognitive processes impact patients' ability to simulate the future.

4.1. Assessment of the strength of the evidence

The strength of the evidence differs by candidate mechanism. Episodic retrieval has substantive correlational evidence that suggests episodic retrieval is associated with future simulation in psychiatric populations. Episodic retrieval is also the only mechanism that has causal evidence supporting its involvement in individuals with depression. Regarding executive control, correlational studies have found a significant association between certain aspects of executive control and future simulation in psychiatric populations. For the remaining mechanisms, there is insufficient evidence to determine whether they contribute to compromised future simulation in psychiatric populations. Specifically, correlational findings between rumination and future simulation are variable, and the few correlational studies for avoidance suggest there is not a significant relationship with future simulation. For scene construction, mental imagery, and narrative style, findings are speculative, since correlational or experimental studies have not directly examined the relationships between future simulation and these potential mechanisms. Based on the current literature, episodic retrieval/simulation seems to be a transdiagnostic mechanism given at least correlational evidence in multiple psychiatric populations. The remaining candidate mechanisms were examined in one or two psychiatric populations, so it is currently unclear if these mechanisms are transdiagnostic.

The focus of the current paper is to review mechanisms of future simulation in psychiatric populations. However, the proposed mechanisms are likely relevant for future simulation in other populations, such as healthy individuals or patients with neurological conditions. For example, there is correlational evidence for episodic retrieval as a mechanism in neurological (Addis, Sacchetti, Ally, Budson, & Schacter, 2009; El Haj, Antoine, & Kapogiannis, 2015; Gamboz et al., 2010) and non-clinical older adult populations (Addis et al., 2008; Addis, Musicaro, Pan, & Schacter, 2010). Episodic retrieval has also been found to have a causal relationship with future simulation in non-clinical young and old individuals (Madore et al., 2014). Additionally, executive functioning has been associated with future simulation in healthy individuals (D'Argembeau, Ortoleva, Jumentier, & Van der Linden, 2010). Future work will be needed to assess whether the remaining mechanisms are relevant across non-clinical, neurological, and psychiatric populations.

While progress has been made in identifying cognitive processes that impact episodic simulation performance in psychiatric populations, there are gaps in the literature. The cognitive mechanisms discussed above have only been explored in certain populations. It is possible that a specific cognitive process may contribute to episodic simulation impairment in one psychiatric population, but not another. For example, patients with anxiety do not tend to present with deficits in their narrative style. However, alterations in narrative style are characteristic of other conditions, such as disorganized speech in schizophrenia, which may impact their performance on an episodic simulation task. An important task for future research is to identify the cognitive processes that contribute to episodic simulation performance in each psychiatric population. A promising area for additional research would be to examine the potential bidirectional relationship between the candidate mechanisms and future simulation. For example, rumination may interfere with retrieval of detailed future simulations, and engaging in future simulation may activate thoughts about the self, resulting in repetitive and passive thinking about one's mood states. However, this work has not been reported.

A limitation of the current literature is that some cognitive processes have been examined only in relation to either objective or subjective measures of episodic simulation. This is an important area of future

research, as cognitive processes discussed above may not contribute similarly to performance on objective measures of episodic simulation (such as the specificity of future descriptions) and the patient's subjective experience. Patients with psychiatric conditions do not perform consistently across objective and subjective measures of episodic simulation, which suggests that underlying cognitive processes are likely not impacting their performance similarly across both measures. For example, Addis et al. (2016) found that patients with depression produced episodic simulations with reduced specificity when compared to controls (as objectively rated by researchers), even though their subjective ratings of detail and emotional intensity did not differ significantly from controls. Future work could attempt to determine whether different cognitive mechanisms impact subjective experience during episodic simulation and objective performance.

The current review focused on episodic simulation. As discussed previously, there are other types of prospection, such as prediction, intention and planning (Szpunar et al., 2014). Research has found impairments across different types of prospection in patients with psychiatric conditions (for an in-depth review, see MacLeod, 2017). Future work will be needed to examine whether the same mechanisms explain impairment in other types of prospection in psychiatric conditions.

4.2. Clinical implications

The cognitive processes that influence episodic simulation performance in psychiatric populations could inform interventions. Interventions have been developed to improve specificity and reduce overgeneralization during autobiographical memory and future thinking. Substantial research has been conducted examining interventions targeting autobiographical memory specificity in psychiatric populations (Barry, Sze, & Raes, 2019; Erten & Brown, 2018; Hitchcock, Werner-Seidler, Blackwell, & Dalgleish, 2017). Outcomes of these interventions include improved performance on autobiographical memory tasks (i.e., increased specificity of memories) and improvements in psychological well-being across various psychiatric populations (Barry et al., 2019; Erten & Brown, 2018; Hitchcock et al., 2017). The impact of episodic specificity induction on future episodic simulation has been examined in non-clinical populations, which found improved psychological well-being (Jing et al., 2016) and reappraisal of negative future events (Jing, Madore, & Schacter, 2017). It is unknown, however, whether these effects impact everyday function, and because these studies were completed in healthy individuals, the findings need to be replicated in patients with psychiatric conditions. McFarland et al. (2017) found improved problem-solving in patients with depression after a specificity induction. Interventions to improve specificity when simulating positive future events have also been beneficial, as these interventions have led to improvements in positive affect (Schubert, Eloo, Scharfen, & Morina, 2020) and promoted engagement in behavioral activation (Renner, Ji, Pictet, Holmes, & Blackwell, 2017). Specificity interventions for episodic simulation may be useful for targeting psychological well-being in psychiatric populations. In clinical practice, therapists may be able to also integrate specificity training into empirically-based interventions, such as confirming their patients are simulating future events in a specific manner when planning behavioral activation activities or when completing exposure therapy about feared future experiences.

Cognitive factors that potentially contribute to episodic simulation impairment in psychiatric populations, such as episodic memory retrieval, scene construction, mental imagery, components of the CaR-FAX model (capture and rumination, functional avoidance, and executive control dysfunction), and narrative style, may also help to explain patients' improvements from specificity interventions. A meta-analysis by Barry et al. (2019) examined potential contributors underlying improved mood and memory specificity following memory specificity training, including executive functioning and rumination. Barry et al. (2019) found that the specificity intervention resulted in improved

executive functioning (i.e., verbal fluency). However, variable findings were present for rumination. Barry et al. (2019) noted that few studies explored these factors, so further research is needed. Targeting the relevant cognitive mechanisms underlying compromised episodic simulation in each psychiatric population could result in tailored and hopefully more effective treatment approaches.

Future work could enhance our understanding of the clinical implications of future simulation. There is ample evidence that future simulation is compromised in psychiatric populations. However, the current studies in psychiatric populations are cross-sectional and do not yet address whether future simulation is a cause or consequence of the disorder. Researchers have hypothesized that compromised future thinking may lead to the maintenance of psychiatric disease (Miloyan, Pachana, & Suddendorf, 2014; Roepke & Seligman, 2016), though this is also an open question. Increased knowledge regarding the clinical implications of future simulation should help to inform whether future simulation interventions are warranted in psychiatric populations.

Funding

DLS's involvement was supported by National Institute of Mental Health grant R01 MH60941 and National Institute on Aging grant R01 AG08441. However, these funding sources played no additional role in the development of the manuscript, writing of the manuscript, or the decision to submit the paper for publication.

CRedit authorship contribution statement

Amanda M. Brunette: Conceptualization, Writing - original draft.
Daniel L. Schacter: Conceptualization, Writing - original draft, Writing - review & editing, Supervision, Funding acquisition.

Declaration of competing interest

None.

References

- Addis, D. R., Hach, S., & Tippett, L. J. (2016). Do strategic processes contribute to the specificity of future simulation in depression? *British Journal of Clinical Psychology*, 55(2), 167–186. <https://doi.org/10.1111/bjc.12103>.
- Addis, D. R., Musicaro, R., Pan, L., & Schacter, D. L. (2010). Episodic simulation of past and future events in older adults: Evidence from an experimental recombination task. *Psychology and Aging*, 25(2), 369.
- Addis, D. R., Sacchetti, D. C., Ally, B. A., Budson, A. E., & Schacter, D. L. (2009). Episodic simulation of future events is impaired in mild Alzheimer's disease. *Neuropsychologia*, 47(12), 2660–2671.
- Addis, D. R., & Schacter, D. (2012). The hippocampus and imagining the future: Where do we stand? *Frontiers in Human Neuroscience*, 5, 173.
- Addis, D. R., Wong, A. T., & Schacter, D. L. (2008). Age-related changes in the episodic simulation of future events. *Psychological Science*, 19(1), 33–41.
- Aleman, A., Bocker, K. B., Hijman, R., de Haan, E. H., & Kahn, R. S. (2003). Cognitive basis of hallucinations in schizophrenia: Role of top-down information processing. *Schizophrenia Research*, 64(2–3), 175–185.
- Aleman, A., de Haan, E. H., & Kahn, R. S. (2005). Object versus spatial visual mental imagery in patients with schizophrenia. *Journal of Psychiatry & Neuroscience*, 30(1), 53–56.
- Altgassen, M., Rendell, P. G., Bernhard, A., Henry, J. D., Bailey, P. E., Phillips, L. H., et al. (2015). Future thinking improves prospective memory performance and plan enactment in older adults. *Quarterly Journal of Experimental Psychology*, 68(1), 192–204.
- Amir, N., Najmi, S., & Morrison, A. S. (2012). Image generation in individuals with generalized social phobia. *Cognitive Therapy and Research*, 36(5), 537–547.
- Anderson, R. J., Boland, J., & Garner, S. R. (2016). Overgeneral past and future thinking in dysphoria: The role of emotional cues and cueing methodology. *Memory*, 24(5), 708–719. <https://doi.org/10.1080/09658211.2015.1046134>.
- Anderson, R. J., & Dewhurst, S. A. (2009). Remembering the past and imagining the future: Differences in event specificity of spontaneously generated thought. *Memory*, 17(4), 367–373.
- Anderson, R. J., & Evans, G. L. (2015). Mental time travel in dysphoria: Differences in the content and subjective experience of past and future episodes. *Consciousness and Cognition*, 37, 237–248. <https://doi.org/10.1016/j.concog.2014.05.006>.
- Anderson, I. M., Haddad, P. M., & Scott, J. (2012). Bipolar disorder. *BMJ*, 345, e8508.
- Arbuckle, T. Y., & Gold, D. P. (1993). Aging, inhibition, and verbosity. *Journal of Gerontology*, 48(5), 225–232.
- Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences*, 5(12), 533–539.
- Aynsworth, C., Nemat, N., Collerton, D., Smailes, D., & Dudley, R. (2017). Reality monitoring performance and the role of visual imagery in visual hallucinations. *Behaviour Research and Therapy*, 97, 115–122. <https://doi.org/10.1016/j.brat.2017.07.012>.
- Barry, T. J., Sze, W. Y., & Raes, F. (2019). A meta-analysis and systematic review of Memory Specificity Training (MeST) in the treatment of emotional disorders. *Behaviour Research and Therapy*, 116, 36–51.
- Baune, B. T., Fuhr, M., Air, T., & Hering, C. (2014). Neuropsychological functioning in adolescents and young adults with major depressive disorder—a review. *Psychiatry Research*, 218(3), 261–271.
- Belcher, J., & Kangas, M. (2014). Reduced goal specificity is associated with reduced memory specificity in depressed adults. *Cognition & Emotion*, 28(1), 163–171. <https://doi.org/10.1080/02699931.2013.807776>.
- Belcher, J., & Kangas, M. (2015). Autobiographical memory and imagining future personal events: Event specificity and symptoms of depression and stress following exposure to an analogue trauma. *Stress and Health*, 31(5), 419–431. <https://doi.org/10.1002/smi.2567>.
- Benoit, R. G., Gilbert, S. J., & Burgess, P. W. (2011). A neural mechanism mediating the impact of episodic prospection on farsighted decisions. *Journal of Neuroscience*, 31(18), 6771–6779.
- Benoit, R. G., & Schacter, D. L. (2015). Specifying the core network supporting episodic simulation and episodic memory by activation likelihood estimation. *Neuropsychologia*, 75, 450–457.
- Blaney, P. H. (1986). Affect and memory: A review. *Psychological Bulletin*, 99(2), 229.
- Blix, I., & Brennen, T. (2011). Mental time travel after trauma: The specificity and temporal distribution of autobiographical memories and future-directed thoughts. *Memory*, 19(8), 956–967. <https://doi.org/10.1080/09658211.2011.618500>.
- Boelen, P. A., Huntjens, R. J., & van den Hout, M. A. (2014). Concurrent and prospective associations of habitual overgeneral memory and prospection with symptoms of depression, general anxiety, obsessive compulsiveness, and post-traumatic stress. *Memory*, 22(7), 747–758. <https://doi.org/10.1080/09658211.2013.824985>.
- Boland, J., Riggs, K. J., & Anderson, R. J. (2018). A brighter future: The effect of positive episodic simulation on future predictions in non-depressed, moderately dysphoric & highly dysphoric individuals. *Behaviour Research and Therapy*, 100, 7–16. <https://doi.org/10.1016/j.brat.2017.10.010>.
- Boulanger, M., Lejeune, A., & Blairy, S. (2013). Overgenerality memory style for past and future events and emotions related in bipolar disorder. What are the links with problem solving and interpersonal relationships? *Psychiatry Research*, 210(3), 863–870. <https://doi.org/10.1016/j.psychres.2013.06.029>.
- Brown, A. D., Addis, D. R., Romano, T. A., Marmar, C. R., Bryant, R. A., Hirst, W., et al. (2014). Episodic and semantic components of autobiographical memories and imagined future events in post-traumatic stress disorder. *Memory*, 22(6), 595–604. <https://doi.org/10.1080/09658211.2013.807842>.
- Brown, A. D., Kouri, N. A., Rahman, N., Joscelyne, A., Bryant, R. A., & Marmar, C. R. (2016). Enhancing self-efficacy improves episodic future thinking and social-decision making in combat veterans with posttraumatic stress disorder. *Psychiatry Research*, 242, 19–25. <https://doi.org/10.1016/j.psychres.2016.05.026>.
- Brown, A. D., Root, J. C., Romano, T. A., Chang, L. J., Bryant, R. A., & Hirst, W. (2013). Overgeneralized autobiographical memory and future thinking in combat veterans with posttraumatic stress disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, 44(1), 129–134. <https://doi.org/10.1016/j.jbtep.2011.11.004>.
- Buckner, R. L., & Carroll, D. C. (2007). Self-projection and the brain. *Trends in Cognitive Sciences*, 11(2), 49–57.
- Carpenter, A. C., & Schacter, D. L. (2017). Flexible retrieval: When true inferences produce false memories. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 43(3), 335.
- Carpenter, A. C., & Schacter, D. L. (2018). False memories, false preferences: Flexible retrieval mechanisms supporting successful inference bias novel decisions. *Journal of Experimental Psychology: General*, 147(7), 988.
- Cassidy, F., Murry, E., Forest, K., & Carroll, B. J. (1998). Signs and symptoms of mania in pure and mixed episodes. *Journal of Affective Disorders*, 50(2–3), 187–201.
- Chen, X. J., Liu, L. L., Cui, J. F., Wang, Y., Chen, A. T., Li, F. H., et al. (2016). Schizophrenia spectrum disorders show reduced specificity and less positive events in mental time travel. *Frontiers in Psychology*, 7, 1121. <https://doi.org/10.3389/fpsyg.2016.01121>.
- Chen, J., Ma, W., Zhang, Y., Yang, L.-q., Zhang, Z., Wu, X., et al. (2014). Neurocognitive impairment of mental rotation in major depressive disorder: Evidence from event-related brain potentials. *The Journal of Nervous and Mental Disease*, 202(8), 594–602.
- Chen, J., Yang, L., Ma, W., Wu, X., Zhang, Y., Wei, D., ... Jia, T. (2013). Ego-rotation and object-rotation in major depressive disorder. *Psychiatry Research*, 209(1), 32–39.
- Cocude, M., Charlot, V., & Denis, M. (1997). Latency and duration of visual mental images in normal and depressed subjects. *Journal of Mental Imagery*, 21(1–2), 127–142.
- Covington, M. A., He, C., Brown, C., Naçi, L., McClain, J. T., Fjordbak, B. S., ... Brown, J. (2005). Schizophrenia and the structure of language: The linguist's view. *Schizophrenia Research*, 77(1), 85–98.
- D'Argembeau, A., Raffard, S., & Van der Linden, M. (2008). Remembering the past and imagining the future in schizophrenia. *Journal of Abnormal Psychology*, 117(1), 247.
- David, A. S., & Cutting, J. C. (1993). Visual imagery and visual semantics in the cerebral hemispheres in schizophrenia. *Schizophrenia Research*, 8(3), 263–271.
- Di Simplico, M., Renner, F., Blackwell, S. E., Mitchell, H., Stratford, H. J., Watson, P., ... Holmes, E. A. (2016). An investigation of mental imagery in bipolar disorder:

- Exploring "the mind's eye." *Bipolar Disorders*, 18(8), 669–683. <https://doi.org/10.1111/bdi.12453>.
- Dickson, J. M., & Bates, G. W. (2006). Autobiographical memories and views of the future: In relation to dysphoria. *International Journal of Psychology*, 41(2), 107–116. <https://doi.org/10.1080/00207590500188025>.
- Dickson, J. M., Moberly, N. J., Hannon, E. M., & Bates, G. W. (2009). Are repressors so special after all? Specificity of negative personal events as a function of anxiety and defensiveness. *Journal of Research in Personality*, 43(3), 386–391. <https://doi.org/10.1016/j.jrp.2009.01.002>.
- Dror, I. E., & Kosslyn, S. M. (1994). Mental imagery and aging. *Psychology and Aging*, 9(1), 90–102.
- D'Argembeau, A., Ortoleva, C., Jumentier, S., & Van der Linden, M. (2010). Component processes underlying future thinking. *Memory & Cognition*, 38(6), 809–819.
- D'Argembeau, A., & Van der Linden, M. (2004). Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and Cognition*, 13(4), 844–858.
- D'Argembeau, A., & Van der Linden, M. (2006). Individual differences in the phenomenology of mental time travel: The effect of vivid visual imagery and emotion regulation strategies. *Consciousness and Cognition*, 15(2), 342–350.
- El Haj, M., Antoine, P., & Kapogiannis, D. (2015). Similarity between remembering the past and imagining the future in Alzheimer's disease: Implication of episodic memory. *Neuropsychologia*, 66, 119–125.
- Erten, M. N., & Brown, A. D. (2018). Memory specificity training for depression and posttraumatic stress disorder: A promising therapeutic intervention. *Frontiers in Psychology*, 9, 419.
- Finnbogadóttir, H., & Berntsen, D. (2014). Looking at life from different angles: Observer perspective during remembering and imagining distinct emotional events. *Psychology of Consciousness: Theory, Research, and Practice*, 1(4), 387–406. <https://doi.org/10.1037/cns0000029>.
- Fleming, K., Goldberg, T. E., Binks, S., Randolph, C., Gold, J. M., & Weinberger, D. R. (1997). Visuospatial working memory in patients with schizophrenia. *Biological Psychiatry*, 41(1), 43–49.
- Foussias, G., & Remington, G. (2008). Negative symptoms in schizophrenia: Avolition and Occam's razor. *Schizophrenia Bulletin*, 36(2), 359–369.
- Gaesser, B., Sacchetti, D. C., Addis, D. R., & Schacter, D. L. (2011). Characterizing age-related changes in remembering the past and imagining the future. *Psychology and Aging*, 26(1), 80.
- Gamble, B., Moreau, D., Tippett, L. J., & Addis, D. R. (2019). Specificity of future thinking in depression: A meta-analysis. *Perspectives on Psychological Science*, 14(5), 816–834.
- Gamboz, N., De Vito, S., Brandimonte, M. A., Pappalardo, S., Galeone, F., Iavarone, A., et al. (2010). Episodic future thinking in amnesic mild cognitive impairment. *Neuropsychologia*, 48(7), 2091–2097.
- Gehrt, T. B., Frostholt, L., Obermann, M.-L., & Berntsen, D. (2019). Autobiographical memory and episodic future thinking in severe health anxiety: A comparison with obsessive-compulsive disorder. *Cognitive Therapy and Research*, 1–19.
- Gilbert, D. T., & Wilson, T. D. (2007). Prospection: Experiencing the future. *Science*, 317(5843), 1351–1354.
- Hach, S., Tippett, L. J., & Addis, D. R. (2014). Neural changes associated with the generation of specific past and future events in depression. *Neuropsychologia*, 65, 41–55. <https://doi.org/10.1016/j.neuropsychologia.2014.10.003>.
- Hallford, D. J., Austin, D. W., Takano, K., & Raes, F. (2018). Psychopathology and episodic future thinking: A systematic review and meta-analysis of specificity and episodic detail. *Behaviour Research and Therapy*, 102, 42–51.
- Hallford, D. J., Barry, T., Austin, D., Raes, F., Takano, K., & Klein, B. (2020a). Impairments in episodic future thinking for positive events and anticipatory pleasure in major depression. *Journal of Affective Disorders*, 260, 536–543.
- Hallford, D. J., Farrell, H., & Lynch, E. (2020). *Increasing anticipated and anticipatory pleasure through episodic thinking*. Washington, DC: Emotion.
- Hallford, D. J., Mellor, D., Bafit, L., Devenish, B., Bogeski, T., Austin, D. W., et al. (2019). The effect of increasing state anxiety on autobiographical memory specificity and future thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, 65, 101488.
- Hallford, D. J., Yeow, J., Fountas, G., Herrick, C., Raes, F., & D'Argembeau, A. (2020). Changing the future: An initial test of future specificity training (FeST). *Behaviour Research and Therapy*, 103638.
- Hassabis, D., Kumaran, D., Vann, S. D., & Maguire, E. A. (2007). Patients with hippocampal amnesia cannot imagine new experiences. *Proceedings of the National Academy of Sciences*, 104(5), 1726–1731.
- Hassabis, D., & Maguire, E. A. (2007). Deconstructing episodic memory with construction. *Trends in Cognitive Sciences*, 11(7), 299–306.
- Hassabis, D., & Maguire, E. A. (2009). The construction system of the brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1521), 1263–1271.
- Hitchcock, C., Werner-Seidler, A., Blackwell, S. E., & Dalgleish, T. (2017). Autobiographical episodic memory-based training for the treatment of mood, anxiety and stress-related disorders: A systematic review and meta-analysis. *Clinical Psychology Review*, 52, 92–107. <https://doi.org/10.1016/j.cpr.2016.12.003>.
- Holmes, E. A., Deeprase, C., Fairburn, C. G., Wallace-Hadrill, S. M., Bonsall, M. B., Geddes, J. R., et al. (2011). Mood stability versus mood instability in bipolar disorder: A possible role for emotional mental imagery. *Behaviour Research and Therapy*, 49(10), 707–713. <https://doi.org/10.1016/j.brat.2011.06.008>.
- Holmes, E. A., Lang, T. J., Moulds, M. L., & Steele, A. M. (2008). Prospective and positive mental imagery deficits in dysphoria. *Behaviour Research and Therapy*, 46(8), 976–981. <https://doi.org/10.1016/j.brat.2008.04.009>.
- Holmes, E. A., & Mathews, A. (2010). Mental imagery in emotion and emotional disorders. *Clinical Psychology Review*, 30(3), 349–362. <https://doi.org/10.1016/j.cpr.2010.01.001>.
- Huddy, V., Drake, G., & Wykes, T. (2016). Mental simulation and experience as determinants of performance expectancies in people with schizophrenia spectrum disorder. *Psychiatry Research*, 237, 97–102. <https://doi.org/10.1016/j.psychres.2016.01.072>.
- Irish, M., & Piolino, P. (2016). Impaired capacity for prospection in the dementias—Theoretical and clinical implications. *British Journal of Clinical Psychology*, 55(1), 49–68.
- Isen, A. M. (1984). Toward understanding the role of affect in cognition. In R. S. Wyer, & T. K. Srull (Eds.), *Handbook of social cognition* (Vol. 3). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
- Jiménez, J. A., Mancini-Marie, A., Lakis, N., Rinaldi, M., & Mendrek, A. (2010). Disturbed sexual dimorphism of brain activation during mental rotation in schizophrenia. *Schizophrenia Research*, 122(1–3), 53–62.
- Jing, H. G., Madore, K. P., & Schacter, D. L. (2016). Worrying about the future: An episodic specificity induction impacts problem solving, reappraisal, and well-being. *Journal of Experimental Psychology: General*, 145(4), 402.
- Jing, H. G., Madore, K. P., & Schacter, D. L. (2017). Preparing for what might happen: An episodic specificity induction impacts the generation of alternative future events. *Cognition*, 169, 118–128. <https://doi.org/10.1016/j.cognition.2017.08.010>.
- Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General*, 117(4), 371–376.
- Joomann, J. (2010). Cognitive inhibition and emotion regulation in depression. *Current Directions in Psychological Science*, 19(3), 161–166.
- Kaltner, S., & Jansen, P. (2014). Emotion and affect in mental imagery: Do fear and anxiety manipulate mental rotation performance? *Frontiers in Psychology*, 5, 792.
- King, M. J., Macdougall, A. G., Ferris, S., Herdman, K. A., & McKinnon, M. C. (2011). Episodic simulation of future events is impaired in patients with major depressive disorder. *Psychiatry Research*, 187(3), 465–467. <https://doi.org/10.1016/j.psychres.2011.02.002>.
- King, M. J., Williams, L. A., MacDougall, A. G., Ferris, S., Smith, J. R., Ziolkowski, N., et al. (2011). Patients with bipolar disorder show a selective deficit in the episodic simulation of future events. *Consciousness and Cognition*, 20(4), 1801–1807. <https://doi.org/10.1016/j.concog.2011.05.005>.
- Kleim, B., Graham, B., Filhosy, S., Stott, R., & Ehlers, A. (2014). Reduced specificity in episodic future thinking in posttraumatic stress disorder. *Clinical Psychological Science*, 2(2), 165–173. <https://doi.org/10.1177/2167702613495199>.
- Klein, S. B. (2013). The complex act of projecting oneself into the future. *Wiley Interdisciplinary Reviews: Cognitive Science*, 4(1), 63–79.
- Knight, R. A., Manoach, D. S., Elliott, D. S., & Hershenson, M. (2000). Perceptual organization in schizophrenia: The processing of symmetrical configurations. *Journal of Abnormal Psychology*, 109(4), 575.
- Kosslyn, S. M. (1981). The medium and the message in mental imagery: A theory. *Psychological Review*, 88(1), 46.
- Kosslyn, S. M. (1995). Mental imagery. In S. M. Kosslyn, & D. N. Osherson (Eds.), *An invitation to cognitive science: Visual cognition* (Vol. 2, pp. 267–296). Cambridge, MA: The MIT Press.
- Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2001). Neural foundations of imagery. *Nature Reviews Neuroscience*, 2(9), 635–642. <https://doi.org/10.1038/35090055>.
- Koster, E. H., De Lissnyder, E., Derakshan, N., & De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective: The impaired disengagement hypothesis. *Clinical Psychology Review*, 31(1), 138–145.
- Labouvie-Vief, G., & Blanchard-Fields, F. (1982). Cognitive ageing and psychological growth. *Ageing and Society*, 2(2), 183–209.
- Lee, J., Folley, B. S., Gore, J., & Park, S. (2008). Origins of spatial working memory deficits in schizophrenia: An event-related fMRI and near-infrared spectroscopy study. *PLoS One*, 3(3). <https://doi.org/10.1371/journal.pone.0001760>.
- Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging*, 17(4), 677.
- MacLeod, A. K. (1996). Affect, emotional disorder, and future-directed thinking. *Cognition & Emotion*, 10(1), 69–86.
- MacLeod, A. K. (2017). *Prospection, well-being, and mental health*. Oxford, England: Oxford University Press.
- MacLeod, A. K., & Cropley, M. L. (1995). Depressive future-thinking: The role of valence and specificity. *Cognitive Therapy and Research*, 19(1), 35–50.
- Madore, K. P., Addis, D. R., & Schacter, D. L. (2015). Creativity and memory: Effects of an episodic specificity induction on divergent thinking. *Psychological Science*, 26(9), 1461–1468. <https://doi.org/10.1177/0956797615591863>.
- Madore, K. P., Gaesser, B., & Schacter, D. L. (2014). Constructive episodic simulation: Dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 40(3), 609–622. <https://doi.org/10.1037/a0034885>.
- Madore, K. P., Jing, H. G., & Schacter, D. L. (2016). Divergent creative thinking in young and older adults: Extending the effects of an episodic specificity induction. *Memory & Cognition*, 44(6), 974–988. <https://doi.org/10.3758/s13421-016-0605-z>.
- Madore, K. P., & Schacter, D. L. (2014). An episodic specificity induction enhances means-end problem solving in young and older adults. *Psychology and Aging*, 29(4), 913.
- Malek, H. B., D'Argembeau, A., Allé, M. C., Meyer, N., Danion, J.-M., & Berna, F. (2019). Temporal processing of past and future autobiographical events in patients with schizophrenia. *Scientific Reports*, 9(1), 1–11.
- Marsh, L., Edginton, T., Conway, M. A., & Loveday, C. (2018). Positivity bias in past and future episodic thinking: Relationship with anxiety, depression, and retrieval-induced forgetting. *Quarterly Journal of Experimental Psychology*, 1–15. <https://doi.org/10.1177/1747021818758620>.

- Matthews, N. L., Collins, K. P., Thakkar, K. N., & Park, S. (2014). Visuospatial imagery and working memory in schizophrenia. *Cognitive Neuropsychiatry*, *19*(1), 17–35. <https://doi.org/10.1080/13546805.2013.779577>.
- Mazhari, S., Tabrizi, Y. M., & Nejad, A. G. (2015). Neural evidence for compromised mental imagery in individuals with chronic schizophrenia. *Journal of Neuropsychiatry and Clinical Neurosciences*, *27*(2), 127–132.
- McFarland, C. P., Primosch, M., Maxson, C. M., & Stewart, B. T. (2017). Enhancing memory and imagination improves problem solving among individuals with depression. *Memory & Cognition*, *45*(6), 932–939. <https://doi.org/10.3758/s13421-017-0706-3>.
- Miloyan, B., Pachana, N. A., & Suddendorf, T. (2014). The future is here: A review of foresight systems in anxiety and depression. *Cognition & Emotion*, *28*(5), 795–810.
- Moran, T. P. (2016). Anxiety and working memory capacity: A meta-analysis and narrative review. *Psychological Bulletin*, *142*(8), 831.
- Morina, N., Deeprose, C., Pusowski, C., Schmid, M., & Holmes, E. A. (2011). Prospective mental imagery in patients with major depressive disorder or anxiety disorders. *Journal of Anxiety Disorders*, *25*(8), 1032–1037. <https://doi.org/10.1016/j.janxdis.2011.06.012>.
- Morrison, A. S., Amir, N., & Taylor, C. T. (2011). A behavioral index of imagery ability in social anxiety. *Cognitive Therapy and Research*, *35*(4), 326–332.
- Mullally, S. L., & Maguire, E. A. (2014). Memory, imagination, and predicting the future: A common brain mechanism? *The Neuroscientist*, *20*(3), 220–234.
- Neroni, M. A., Gamboz, N., & Brandimonte, M. A. (2014). Does episodic future thinking improve prospective remembering? *Consciousness and Cognition: International Journal*, *23*, 53–62. <https://doi.org/10.1016/j.concog.2013.12.001>.
- Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology*, *100*(4), 569.
- de Oliveira, H., Cuervo-Lombard, C., Salame, P., & Danion, J. M. (2009). Autooetic awareness associated with the projection of the self into the future: An investigation in schizophrenia. *Psychiatry Research*, *169*(1), 86–87. <https://doi.org/10.1016/j.psychres.2008.07.003>.
- Ottenbreit, N. D., & Dobson, K. S. (2004). Avoidance and depression: The construction of the cognitive-behavioral avoidance scale. *Behaviour Research and Therapy*, *42*(3), 293–313.
- Painter, J. M., & Kring, A. M. (2016). Toward an understanding of anticipatory pleasure deficits in schizophrenia: Memory, prospection, and emotion experience. *Journal of Abnormal Psychology*, *125*(3), 442–452. <https://doi.org/10.1037/abn0000151>.
- Palombo, D., Hayes, S., Peterson, K., Keane, M., & Verfaellie, M. (2016). Medial temporal lobe contributions to episodic future thinking: Scene construction or future projection? *Cerebral Cortex*, *28*(2), 447–458.
- Pan, Y. J., Hsieh, M. H., & Liu, S. K. (2011). Visuospatial working memory deficits in remitted patients with bipolar disorder: Susceptibility to the effects of GABAergic agonists. *Bipolar Disorders*, *13*(4), 365–376.
- Park, S., & Holzman, P. S. (1992). Schizophrenics show spatial working memory deficits. *Archives of General Psychiatry*, *49*(12), 975–982.
- Park, S., Puschel, J., Sauter, B. H., Rentsch, M., & Hell, D. (1999). Spatial working memory deficits and clinical symptoms in schizophrenia: A 4-month follow-up study. *Biological Psychiatry*, *46*(3), 392–400.
- Parlar, M., Lee, A., Haqqee, Z., Rhooms, L., Lanius, R. A., & McKinnon, M. C. (2016). Parental bonding and neuropsychological performance are associated with episodic simulation of future events in trauma-exposed patients with major depressive disorder. *Brain and Behavior*, *6*(7). <https://doi.org/10.1002/brb3.474>. e00474.
- Parsons, L. M. (1987). Imagined spatial transformations of one's hands and feet. *Cognitive Psychology*, *19*(2), 178–241.
- Pearson, D. G., Deeprose, C., Wallace-Hadrill, S. M., Burnett Heyes, S., & Holmes, E. A. (2013). Assessing mental imagery in clinical psychology: A review of imagery measures and a guiding framework. *Clinical Psychology Review*, *33*(1), 1–23. <https://doi.org/10.1016/j.cpr.2012.09.001>.
- Pearson, J., Naselaris, T., Holmes, E. A., & Kosslyn, S. M. (2015). Mental imagery: Functional mechanisms and clinical applications. *Trends in Cognitive Sciences*, *19*(10), 590–602. <https://doi.org/10.1016/j.tics.2015.08.003>.
- Peters, J., & Büchel, C. (2010). Episodic future thinking reduces reward delay discounting through an enhancement of prefrontal-mediotemporal interactions. *Neuron*, *66*(1), 138–148.
- Piskulic, D., Olver, J. S., Norman, T. R., & Maruff, P. (2007). Behavioural studies of spatial working memory dysfunction in schizophrenia: A quantitative literature review. *Psychiatry Research*, *150*(2), 111–121. <https://doi.org/10.1016/j.psychres.2006.03.018>.
- Raffard, S., Bortolon, C., D'Argembeau, A., Gardes, J., Gely-Nargeot, M. C., Capdevielle, D., et al. (2016). Projecting the self into the future in individuals with schizophrenia: A preliminary cross-sectional study. *Memory*, *24*(6), 826–837. <https://doi.org/10.1080/09658211.2015.1057152>.
- Raffard, S., D'Argembeau, A., Bayard, S., Boulenger, J. P., & Van der Linden, M. (2010). Scene construction in schizophrenia. *Neuropsychology*, *24*(5), 608–615. <https://doi.org/10.1037/a0019113>.
- Raffard, S., Esposito, F., Boulenger, J. P., & Van der Linden, M. (2013). Impaired ability to imagine future pleasant events is associated with apathy in schizophrenia. *Psychiatry Research*, *209*(3), 393–400. <https://doi.org/10.1016/j.psychres.2013.04.016>.
- Raune, D., MacLeod, A., & Holmes, E. A. (2005). The simulation heuristic and visual imagery in pessimism for future negative events in anxiety. *Clinical Psychology & Psychotherapy*, *12*(4), 313–325. <https://doi.org/10.1002/cpp.455>.
- Renner, F., Ji, J. L., Pictet, A., Holmes, E. A., & Blackwell, S. E. (2017). Effects of engaging in repeated mental imagery of future positive events on behavioural activation in individuals with major depressive disorder. *Cognitive Therapy and Research*, *41*(3), 369–380. <https://doi.org/10.1007/s10608-016-9776-y>.
- Robinaugh, D. J., Lubin, R. E., Babic, L., & McNally, R. J. (2013). Are habitual overgeneral recollection and prospection maladaptive? *Journal of Behavior Therapy and Experimental Psychiatry*, *44*(2), 227–230. <https://doi.org/10.1016/j.jbtep.2012.11.002>.
- Roche, E., Creed, L., MacMahon, D., Brennan, D., & Clarke, M. (2014). The epidemiology and associated phenomenology of formal thought disorder: A systematic review. *Schizophrenia Bulletin*, *41*(4), 951–962.
- Rock, P., Roiser, J., Riedel, W., & Blackwell, A. (2014). Cognitive impairment in depression: A systematic review and meta-analysis. *Psychological Medicine*, *44*(10), 2029–2040.
- Roepke, A. M., & Seligman, M. E. (2016). Depression and prospection. *British Journal of Clinical Psychology*, *55*(1), 23–48.
- Rogers, M., Bradshaw, J., Phillips, J., Chiu, E., Mileskin, C., & Vaddadi, K. (2002). Mental rotation in unipolar major depression. *Journal of Clinical and Experimental Neuropsychology*, *24*(1), 101–106.
- Romero, K., & Moscovitch, M. (2012). Episodic memory and event construction in aging and amnesia. *Journal of Memory and Language*, *67*(2), 270–284. <https://doi.org/10.1016/j.jml.2012.05.002>.
- Rubin, D. C., Schrauf, R. W., & Greenberg, D. L. (2003). Belief and recollection of autobiographical memories. *Memory & Cognition*, *31*(6), 887–901.
- Sansom-Daly, U. M., Bryant, R. A., Cohn, R. J., & Wakefield, C. E. (2014). Imagining the future in health anxiety: The impact of rumination on the specificity of illness-related memory and future thinking. *Anxiety, Stress & Coping*, *27*(5), 587–600. <https://doi.org/10.1080/10615806.2014.880111>.
- Schacter, D. L. (2019). Implicit memory, constructive memory, and imagining the future: A career perspective. *Perspectives on Psychological Science*, *14*(2), 256–272. <https://doi.org/10.1177/1745691618803640>.
- Schacter, D. L., & Addis, D. R. (2007). The cognitive neuroscience of constructive memory: Remembering the past and imagining the future. *Philosophical Transactions of the Royal Society of London B Biological Sciences*, *362*(1481), 773–786.
- Schacter, D. L., & Addis, D. R. (2020). Memory and imagination: Perspectives on constructive episodic simulation. In A. Abraham (Ed.), *The Cambridge handbook of the imagination* (pp. 111–131). Cambridge: Cambridge University Press.
- Schacter, D. L., Addis, D. R., & Buckner, R. L. (2007). Remembering the past to imagine the future: The prospective brain. *Nature Reviews Neuroscience*, *8*(9), 657.
- Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events: Concepts, data, and applications. *Annals of the New York Academy of Sciences*, *1124*(1), 39–60.
- Schacter, D. L., Addis, D. R., Hassabis, D., Martin, V. C., Spreng, R. N., & Szpunar, K. K. (2012). The future of memory: Remembering, imagining, and the brain. *Neuron*, *76*(4), 677–694. <https://doi.org/10.1016/j.neuron.2012.11.001>.
- Schacter, D. L., Benoit, R. G., & Szpunar, K. K. (2017). Episodic future thinking: Mechanisms and functions. *Current Opinion in Behavioral Sciences*, *17*, 41–50.
- Schacter, D. L., Devitt, A. L., & Addis, D. R. (2018). Episodic future thinking and cognitive aging. *Oxford research encyclopedia of psychology*. Oxford University Press.
- Schacter, D. L., Gaesser, B., & Addis, D. R. (2013). Remembering the past and imagining the future in the elderly. *Gerontology*, *59*(2), 143–151.
- Schacter, D. L., & Madore, K. P. (2016). Remembering the past and imagining the future: Identifying and enhancing the contribution of episodic memory. *Memory Studies*, *9*(3), 245–255. <https://doi.org/10.1177/1750698016645230>.
- Schrijvers, D., Hulstijn, W., & Sabbe, B. G. (2008). Psychomotor symptoms in depression: A diagnostic, pathophysiological and therapeutic tool. *Journal of Affective Disorders*, *109*(1–2), 1–20.
- Schubert, T., Eloo, R., Scharfen, J., & Morina, N. (2020). How imagining personal future scenarios influences affect: Systematic review and meta-analysis. *Clinical Psychology Review*, *75*, 101811.
- Schultz, S. K., & Andreasen, N. C. (1999). Schizophrenia. *Lancet*, *353*(9162), 1425–1430.
- Seligman, M. E., Railton, P., Baumeister, R. F., & Sripada, C. (2013). Navigating into the future or driven by the past. *Perspectives on Psychological Science*, *8*(2), 119–141.
- Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: A meta-analysis and review. *Psychological Bulletin*, *139*(1), 81.
- Sobin, C., & Sackeim, H. A. (1997). Psychomotor symptoms of depression. *American Journal of Psychiatry*, *154*(1), 4–17.
- Soraggi-Frez, C., Santos, F. H., Albuquerque, P. B., & Malloy-Diniz, L. F. (2017). Disentangling working memory functioning in mood states of bipolar disorder: A systematic review. *Frontiers in Psychology*, *8*, 574.
- Stöber, J. (2000). Prospective cognitions in anxiety and depression: Replication and methodological extension. *Cognition & Emotion*, *14*(5), 725–729.
- Szpunar, K. K. (2010). Episodic future thought: An emerging concept. *Perspectives on Psychological Science*, *5*(2), 142–162.
- Szpunar, K. K., Spreng, R. N., & Schacter, D. L. (2014). A taxonomy of prospection: Introducing an organizational framework for future-oriented cognition. *Proceedings of the National Academy of Sciences*, *111*(52), 18414–18421.
- Terrett, G., Rose, N. S., Henry, J. D., Bailey, P. E., Altgassen, M., Phillips, L. H., et al. (2016). The relationship between prospective memory and episodic future thinking in younger and older adulthood. *Quarterly Journal of Experimental Psychology*, *69*(2), 310–323.
- Trapnell, P. D., & Campbell, J. D. (1999). Private self-consciousness and the five-factor model of personality: Distinguishing rumination from reflection. *Journal of Personality and Social Psychology*, *76*(2), 284.
- Trunk, D. L., & Abrams, L. (2009). Do younger and older adults' communicative goals influence off-topic speech in autobiographical narratives? *Psychology and Aging*, *24*(2), 324.

- de Vignemont, F., Zalla, T., Posada, A., Louvegnez, A., Koenig, O., Georgieff, N., et al. (2006). Mental rotation in schizophrenia. *Consciousness and Cognition*, *15*(2), 295–309.
- Wang, Y., Wang, Y., Zhao, Q., Cui, J. F., Hong, X. H., & Chan, R. C. (2017). Preliminary study of visual perspective in mental time travel in schizophrenia. *Psychiatry Research*, *256*, 225–227. <https://doi.org/10.1016/j.psychres.2017.06.062>.
- Ward, A. M. (2016). A critical evaluation of the validity of episodic future thinking: A clinical neuropsychology perspective. *Neuropsychology*, *30*(8), 887.
- Whitmer, A. J., & Gotlib, I. H. (2013). An attentional scope model of rumination. *Psychological Bulletin*, *139*(5), 1036.
- Williams, J. M. G. (2006). Capture and rumination, functional avoidance, and executive control (CaRFAX): Three processes that underlie overgeneral memory. *Cognition & Emotion*, *20*(3–4), 548–568. <https://doi.org/10.1080/02699930500450465>.
- Williams, J. M. G., Barnhofer, T., Crane, C., Herman, D., Raes, F., Watkins, E., et al. (2007). Autobiographical memory specificity and emotional disorder. *Psychological Bulletin*, *133*(1), 122.
- Williams, J. M. G., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *Journal of Abnormal Psychology*, *95*(2), 144–149.
- Williams, J. M. G., & Dritschel, B. H. (1988). Emotional disturbance and the specificity of autobiographical memory. *Cognition & Emotion*, *2*(3), 221–234.
- Williams, J. M. G., Ellis, N. C., Tyers, C., Healy, H., Rose, G., & Macleod, A. K. (1996). The specificity of autobiographical memory and imageability of the future. *Memory & Cognition*, *24*(1), 116–125.
- Winfield, H., & Kamboj, S. K. (2010). Schizotypy and mental time travel. *Consciousness and Cognition*, *19*(1), 321–327. <https://doi.org/10.1016/j.concog.2009.11.011>.
- Wu, J. Q., Szpunar, K. K., Godovich, S. A., Schacter, D. L., & Hofmann, S. G. (2015). Episodic future thinking in generalized anxiety disorder. *Journal of Anxiety Disorders*, *36*, 1–8. <https://doi.org/10.1016/j.janxdis.2015.09.005>.
- Yang, Z.-y., Wang, S.-k., Li, Y., Wang, Y., Wang, Y.-m., Zhou, H.-y., ... Öngür, D. (2019). Neural correlates of prospection impairments in schizophrenia: Evidence from voxel-based morphometry analysis. *Psychiatry Research: Neuroimaging*, *293*, 110987.
- Yang, Z.-y., Xie, D.-j., Zou, Y.-m., Wang, Y., Li, Y., Shi, H.-s., ... Kring, A. M. (2018). Prospection deficits in schizophrenia: Evidence from clinical and subclinical samples. *Journal of Abnormal Psychology*, *127*(7), 710.
- Zarrinpar, A., Deldin, P., & Kosslyn, S. M. (2006). Effects of depression on sensory/motor vs. central processing in visual mental imagery. *Cognition & Emotion*, *20*(6), 737–758.