COGNITIVE PROCESSES UNDERLYING EPISODIC MENTAL TIME TRAVEL

ÇAĞLA DUMAN

BOĞAZİÇİ UNIVERSITY

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Çağla Duman

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DECLARATION OF ORIGINALITY

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ABSTRACT

Cognitive Processes Underlying Episodic Mental Time Travel

Episodic mental time travel, the mental construction of the past and future through remembering and imagining, is one of the cognitive abilities that have been extensively studied over the past 20 years. Although a range of component processes was proposed to underlie this unique ability, their relative contributions have remained largely unclear. The current study investigated the role of episodic memory, scene construction, self-projection, and visual imagery in autobiographical memory, episodic future thinking, and episodic counterfactual thinking. Participants recalled and imagined important past, future, and counterfactual events and rated their phenomenological quality, and completed measures of several cognitive functions thought to underlie episodic mental time travel (i.e., episodic memory, scene construction, self-projection, and visual imagery). The number of episodic details found in the narratives of these events was also examined using an adapted version of the Autobiographical Interview. The results indicated that visual imagery and scene construction predicts the phenomenological quality and episodic details of autobiographical memories, respectively, while episodic memory predicts the subjective experience of episodic future events. The results were discussed with reference to the existing theoretical propositions.

ÖZET

Episodik Zihinsel Zaman Yolculuğunun Altında Yatan Bilişsel Süreçler

Hatırlama ve hayal etme yoluyla geçmişin ve geleceğin zihinsel inşası olarak tanımlanabilecek olan episodik zihinsel zaman yolculuğu, son 20 yılda kapsamlı bir şekilde incelenen bilişsel becerilerden biridir. Bu becerinin altında yatan bir dizi bilişsel süreç önerilmiş olsa da bunların görece katkıları açık biçimde henüz ortaya konulmamıştır. Bu çalışma, otobiyografik bellek, episodik gelecek düşüncesi ve episodik karşıolgusal (counterfactual) düşüncede episodik bellek, sahne inşası, benlik yansıtma ve görsel imgelemin rolünü araştırmıştır. Katılımcılar geçmişten, gelecekten ve karşıolgusal geçmişten önemli olaylar hatırlayıp hayal etmiş, bu olayların fenomenolojik özelliklerini değerlendirmiş ve episodik zihinsel zaman yolculuğunun altında yattığı ileri sürülen çeşitli bilişsel işlevlere dair (episodik bellek, sahne inşası, bakış açısı alma ve görsel imgelemdeki bireysel farklılıklar) ölçümler tamamlamışlardır. Anı/olay anlatılarında bulunan olaya özgü ayrıntıların sayısı da Otobiyografik Mülakat prosedürünün uyarlanmış bir versiyonu kullanılarak incelenmiştir. Sonuçlar, görsel imgelemin ve sahne inşasının, otobiyografik anıların sırasıyla fenomenolojik kalitesini ve olaya özgü ayrıntılarını, episodik belleğin ise episodik gelecek olayların öznel deneyimini yordadığını göstermiştir. Bulgular, mevcut teorik yaklaşımlar bağlamında tartışılmıştır.

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CHAPTER 1

INTRODUCTION

Disentangling oneself from the present moment and mentally traveling back and forth in time to re-experience the past or pre-experience the future can be considered a unique property of the human mind that has been an object of research since the seminal works of Tulving (1985, 2002). Over the last two decades, research on episodic mental time travel has focused on identifying its forms and underlying cognitive mechanisms. In this vein, episodic autobiographical memory (Suddendorf & Corballis, 1997; Tulving, 1983), episodic future thinking (Atance & O'Neill, 2001), and more recently, episodic counterfactual thinking (De Brigard et al., 2013) were shown to be modes of episodic mental time travel, which arguably differ from each other in terms of their relationship with reality and temporal orientation (De Brigard & Parikh, 2019). In terms of its underlying cognitive mechanisms, research described a variety of processes, such as scene construction (Hassabis & Maguire, 2007), episodic memory (Schacter & Addis, 2007a), self-projection (Buckner & Carroll, 2007), and visual imagery (Rubin, 2006). The present study was built upon these two lines of research and aimed to investigate the cognitive processes underlying episodic mental time travel by examining their relative contributions to autobiographical memory, episodic future thinking, and episodic counterfactual thinking.

1.1 Characterizing episodic mental time travel

Episodic memory was first introduced by Tulving (1972) as the neurocognitive faculty that stores the representations of personally experienced past events, in contrast to

semantic memory, which is devoted to general facts and information. The conceptualization of episodic memory has shifted from being a mere repository of the past to a system that subserves mental time travel into the past and the future, with the observation that amnesic patients, who display episodic memory impairments, were also unable to imagine future events. In this regard, episodic mental time travel refers to the mental construction of the past and the future in which one re-experiences the past and pre-experiences the future (Suddendorf & Corballis, 1997).

Following up on this idea, the evidence accumulated from cognitive psychology, neuropsychology, and cognitive neuroscience demonstrated striking similarities between autobiographical remembering and episodic future thinking.

In terms of phenomenology, when asked to recall or imagine past and future events that differ in valence and temporal distance, participants rated positive and recent events as involving more sensory details, a clearer time perspective, and a stronger feeling of experiencing than negative and distant events (D'Argembeau &Van der Linden, 2004). Likewise, individuals with higher visual imagery and emotion regulation abilities reported past and future events with more visual and other sensory details than those with lower abilities (D'Argembeau & Van der Linden, 2006). Developmental processes were also related to similar changes in episodic memory and episodic future thinking during early childhood (for a review, see Atance & O'Neill, 2005) and old adulthood (for reviews, see Levine, 2004; Schacter et al., 2018). Busby and Suddendorf (2005) asked children ranging in age between 3 to 5 to report events that occurred the day before and might occur tomorrow, as well as events that had not happened yesterday and would not happen tomorrow. They found that the ability to recall the past and think about the future emerges between the ages of 3 and 5, as a small proportion of 3-year-

olds and most older children successfully answered these questions. In terms of aging, it was found that when asked to recall autobiographical memories and produce future episodes by recombining the elements of these memories (i.e., individuals, objects, and locations), compared to their younger counterparts, older adults generate fewer episodic details for recalled and imagined events (Addis et al., 2010). Further, patients with various neurological and psychopathological conditions, including amnesia (Hassabis et al., 2007; Klein et al., 2002), amnesic mild cognitive impairment (Gamboz et al., 2010), Alzheimer's disease (Addis et al., 2009; El Haj et al., 2016), depression (Williams et al., 1996), and schizophrenia (D'Argembeau et al., 2008) showed similar deficits in their ability to remember the past and imagine the future. Finally, recollecting a past event and envisioning a future episode was related to activations in similar areas of the brain (Okuda et al., 2003; Addis et al., 2007; Szpunar et al., 2007), including the default mode network (the DMN) and medial temporal lobes (Buckner et al., 2008).

Although episodic future thinking was understood as a form of episodic mental time travel more than two decades ago, the study of episodic counterfactual thinking, which refers to the ability to imagine alternatives to past events, has not been linked to this line of research until recently (De Brigard & Parikh, 2019). Within the context of episodic mental time travel, episodic counterfactual thinking is similar to autobiographical memories as both involve events in the past and to episodic future thinking since both processes involve simulation of imagined (i.e., nonactual) events (De Brigard & Parikh, 2019). To compare the characteristics of these events with each other, studies typically asked participants to recall an autobiographical memory, imagine an event that they would plausibly experience in the future (episodic future thinking), and generate episodic counterfactuals (episodic counterfactual thinking). While the study of

episodic counterfactual thinking has employed different approaches, a common way is to ask participants to imagine an event that might have occurred in the past.

It has been shown that remembering the past, envisioning the future, and imagining events that could have happened in the past were similarly influenced by experimental manipulations. When De Brigard and Giovanello (2012) asked participants to report autobiographical, future, and counterfactual events that differed in outcome valence, events with positive outcomes were experienced more intensely than those with negative ones. Further, regardless of their outcome valence, autobiographical memories were more vivid and coherent and involved more sensory details than imagined events. Similarly, Özbek et al. (2017) asked participants to remember and imagine autobiographical, future, and counterfactual events from the last/next month, year, and five or more years. They found that temporal distance had a similar influence on the content of these events, as temporally distant autobiographical memories, future projections, and counterfactuals were more about the events that were expected to be experienced by members of the culture (i.e., cultural life script events). Further, with increasing temporal distance, importance and centrality of these events also increased, while the sensory details decreased. Autobiographical memory, episodic future thinking, and episodic counterfactual thinking also showed similar developmental changes. De Brigard et al. (2016) asked younger and older adults to recall and imagine past, counterfactual, and future events of different degrees of perceived likelihood and positivity and rate their phenomenological characteristics. They found that across all three simulations, older adults generate more vivid and intense events that involve more external details while younger adults produce events with more internal details and perceive future events as more likely than did older adults. Further, individuals with

neuropsychological and psychopathological conditions that involve difficulties in remembering the past and imagining the future, including amnesia (Mullally & Maguire, 2014), the ventral medial prefrontal cortex and the lateral orbital frontal cortex damage (Levens et al., 2014), and schizophrenia (Hooker et al., 2000), showed similar difficulties during episodic counterfactual thinking. Finally, the DMN was similarly activated by the autobiographical recall and episodic future thinking, as well episodic counterfactual thinking (Addis et al., 2009a; De Brigard et al., 2013; De Brigard et al., 2015; Van Hoeck et al., 2010; Van Hoeck et al., 2013).

Taken together, these findings also support the idea that autobiographical recall, episodic future thinking, and episodic counterfactual thinking might be supported by a set of common mechanisms, which give rise to their phenomenological, developmental, and neural similarities. Linking episodic counterfactual thinking to the process of mental construction of the past and future also provided a more symmetrical view of episodic mental time travel that is not based on the "past-experienced and future-imagined" dichotomy (De Brigard et al., 2016). Thus, the current conceptualization of episodic mental time travel views it as the intersection of memory and imagination, which is characterized by the mental rendering of experience within the broader context of episodic simulation (Addis, 2020).

1.2 Cognitive mechanisms underlying episodic mental time travel

It has been suggested that episodic mental time travel was critically dependent on other cognitive processes that are shared by remembering and imagining, rather than being a uniform and independent cognitive capacity (Suddendorf & Corballis, 1997). Concordantly, previous research has identified a number of related processes that argued

to be involved in remembering the past and imagining the future (Buckner & Carroll, 2007; Hassabis & Maguire, 2007; Schacter & Addis, 2007a; Suddendorf & Corballis, 2007).

Tulving (2002, 2005) claimed that episodic memory subserves the capacity of remembering the past and imagining the future through autonoetic consciousness, which constitutes the representation of self in subjective time. In this sense, mental time travel requires the capacity for recognizing the self as a distinct entity that exists outside the present moment and locating past and future events along a temporal continuum.

In a similar vein, Schacter and Addis (2007a) put forward the *constructive episodic simulation hypothesis*, based on the idea that episodic memory is a (re)constructive system that pieces the elements of past experiences spread throughout the brain together, rather than a reproductive one that would store the mere records of the past. Although having a constructive memory system makes it susceptible to errors and confabulations, one significant utility is that it can simulate events that might occur in the future. As the future events are not exact replications of those experienced in the past, a reproductive memory system would not be well suited for imagining novel future episodes (Schacter & Addis, 2007b). Thus, the constructive nature of episodic memory facilitates simulating plausible future occurrences by extracting bits of information from the past and flexibly recombining and integrating them into novel and coherent future representations. In this regard, the capacity to mentally travel in time depends on episodic memory, which provides the essential elements for the imagined events.

This idea was supported by several studies using experimental manipulations to episodic memory contribution and comparing different age groups (for reviews, see Schacter et al., 2013; van Genugten & Schacter, 2021). Envisioned future scenarios

taking place in familiar contextual settings that are represented with greater perceptual detail (e.g., home and university campus) were associated with stronger subjective experience than those occurring in unfamiliar settings that are represented with fewer perceptual detail (e.g., jungle and high school; Szpunar & McDermott, 2008). Investigating the relationship between autobiographical memory, episodic future thinking, and vantage point, McDermott et al. (2016) found that distributions of observer perspectives were similar across the event types, which suggests that similar constructive mechanisms might be supporting both processes. When young and older participants recalled autobiographical memories and imagined future episodes, older adults' both past and future event descriptions involved fewer internal details compared to their younger counterparts (Addis et al., 2008). Importantly, episodic specificity induction, a brief training procedure used to selectively enhance episodic memory processes, was found to be related to increased episodic, but not semantic, details for past and future events in both young and older adults (Madore et al., 2014).

Besides Tulving's earlier conceptualization of episodic memory, neuroimaging evidence showing that a range of cognitive functions, including remembering the past and imagining the future, similarly activates the DMN, which involves frontal and medial temporal-parietal lobes structures, has also driven research concerning the cognitive mechanisms underlying episodic mental time travel (for reviews, see Buckner et al., 2008; Spreng et al., 2009).

Buckner and Carroll (2007) proposed *self-projection*, which refers to "the ability to shift perspective from the immediate present to alternative perspectives" (p. 49), as the common underlying cognitive process of episodic memory, future thinking, theory of mind, and navigation. Although traditionally considered distinct, these four cognitive

functions are related to the activation of the same core brain system (i.e., the DMN) and require a shift from the immediate environment to facilitate the mental rendering of different perspectives that are imagined about the self (Buckner & Carroll, 2007). Herein, the utility of episodic memory is in its ability to construct mental models of different temporal (i.e., past and future) and personal (i.e., alternative location and another person's viewpoint) perspectives. While autobiographical recall and future thinking require the ability to mentally project oneself into the past and future, understanding others' mental states and forming mental maps of the environment demands the ability to shift to an alternative perspective that differs from one's own. As such, Buckner and Carroll argued that episodic mental time travel is best understood as a form of self-projection that relies on autobiographical knowledge.

The evidence for self-projection theory is relatively scarce and comes from several developmental studies with children and older adults (for reviews, see Perner, 2000) and studies on psychological and neurodegenerative disorders (for a review, see Moreau et al., 2013). Both episodic memory and theory of mind emerge roughly around the same age period (Perner et al., 2007; Perner & Ruffman, 1995; see also Naito, 2003). Comparing healthy young and older adults on episodic memory, episodic future thinking, and theory of mind, Jarvis and Miller (2017) found that aging affected these processes similarly, as older adults performed poorly on tasks assessing episodic mental time travel and theory of mind abilities compared to younger adults. To examine the relationship between theory of mind and autobiographical memory, Adler et al. (2010) compared individuals with high-functioning autism and Asperger syndrome to healthy controls and found that theory of mind abilities of these patient groups could be predicted by their performance on an autobiographical memory details task.

Building on a similar observation, Hassabis and Maguire (2007) claimed that *scene construction*, "the process of mentally generating and maintaining a complex and coherent scene or event" (p. 299), better accounts for the DMN engagement by the cognitive functions that do not involve the process of self-projection, such as imagination. They argued that an extended range of disparate cognitive functions are related in the sense that each depends on scene construction as the underlying core process. Scene construction is not necessarily dependent on the subjective experience of self and temporally extended time and is achieved by retrieving relevant informational components from their modality-specific cortical areas and bounding them in a coherent spatial context to be manipulated and visualized (Hassabis et al., 2007). In this regard, recollecting an autobiographical memory, simulating a future event, navigating through a map, and imagining a fictitious scene that is a pure product of one's imagination, are almost always accompanied by complex mental imagery within a spatial context in which the event is played out. Thus, constructing a complex and coherent scene is an integral process that supports episodic mental time travel.

This idea was supported by several neuropsychological and experimental studies (for a review, see Teghil et al., 2021). Hassabis et al. (2007) tested participants with hippocampal amnesia on the scene construction task, which required them to imagine fictitious scenes that are not explicitly temporal and self-relevant in nature. They found that compared to healthy controls, those with amnesia were significantly impaired at scene construction, producing descriptions that lack spatial coherence and details. Similarly, when asked to imagine new fictitious experiences and describe their mental representations, participants with schizophrenia, a psychological disorder associated with impairments in autobiographical memory and episodic future thinking, produced

descriptions that are more fragmented with fewer details, compared to healthy controls (Raffard et al., 2010). Further, de Vito et al. (2012) compared episodic future events (e.g., "Imagine being at the university next year") with imagined atemporal events (e.g., "Imagine sitting in a crowded pub"), and found that episodic future events were indistinguishable from atemporal ones in terms of their sensory details, clarity of context, number of details, as well as feeling of experiencing. Finally, when participants were provided with spatial contextual cues and asked to recall autobiographical memories, picture atemporal scenes, and imagine future events, cues of high levels of familiarity increased the accessibility and the quality of scenes and past and future events compared to less familiar ones (Robin & Moscovitch, 2014).

These views, particularly the scene construction theory, hold a similar argument with the *basic-systems model of autobiographical memory* (Rubin, 2006) and the *event memory account* (Rubin & Umanath, 2015). The basic-systems model characterizes autobiographical recall as an interplay between sensory and declarative systems that process different kinds of information. The explicit memory system binds information from sensory, spatial, emotional, narrative, and language systems to create the sense of recollection and the belief that what is remembered is an accurate representation of the past. Although each system has a specific function with regards to memory, the role of visual imagery is highlighted as the richness of the phenomenology of an event is most strongly associated with the vividness of its visual imagery (for a review, see Rubin, 2005). Examining the effect of visual input at encoding on recall of autobiographical memories, Rubin et al. (2003a) found that lack of visual input was related to poor phenomenological quality. Similarly, Greenberg and Knowlton (2014) found that visual imagery was associated with the feeling of reliving autobiographical memories among

individuals with different cognitive styles, and individuals with a congenital absence of visual imagery were reliving their memories to a lesser degree compared to controls. When presented with word phrases (e.g., “relaxing on a beach” and “supportive friend”) and asked to produce voluntary and involuntary autobiographical memories in response to cues, compared to those with low object imagery abilities, participants who are higher on object imagery generated more voluntary and involuntary memories that are more detailed (Vannucci et al., 2016). A similar finding was also obtained by Aydın (2018), as the object imagery predicted visual details, emotional intensity, and coherence of autobiographical memories. As visual imagery is intimately related to autobiographical recall, by extension, it might also underlie our ability to imagine the future and the counterfactual past. Here, it is also important to highlight a significant distinction between visual imagery and scene construction as both involve the generation of mental images and, thus, might appear as similar processes. While visual imagery is a modality-specific process (i.e., vision), scene construction is multimodal in the sense that it is characterized by the flexible integration of different sensory-spatial elements into a coherent whole.

The event memory account highlights the role of spatial processing, which provides the memory with its most basic context that allows the content to be organized (Rubin & Umanath, 2015). They define event memory as the mental construction of a scene, which differs from semantic and other autobiographical memories that do not involve a clear spatial organization of objects and people (Rubin, 2022). Within this framework, scene construction is achieved by placing the mind’s eye into a single spatial location that oversees the other elements in the scene and their relative positions to the individual. Importantly, in the event memory account, Rubin and Umanath replaced the

central idea of sense of reliving with the process of mental construction of a scene as it was better situated within the existing literature that accumulates evidence from cognitive psychology and cognitive neuroscience. In this regard, Rubin (2020) found that the clarity of the spatial organization in which the event takes place was associated more highly than the clarity of content with its phenomenological quality. Further, they also showed that the ability to recall scenes was correlated with individual differences in episodic memory and future thinking, which suggests that scene construction might be a stable individual-difference variable. It should be noted that although both Hassabis and Maguire and Rubin and Umanath emphasize the role of scene construction in autobiographical memory, they use this term to refer to related but different processes. While the scene construction theory (Hassabis & Maguire, 2007) uses the term to refer to a core cognitive process, the event memory account (Rubin & Umanath, 2015) conceptualizes scene construction as the process in which event memories involve a clear spatial layout that places the recaller in relation to the other elements of the scene.

1.3 Literature review

Although the theoretical claims support the view that multiple cognitive processes underlie episodic mental time travel, there have been few empirical examinations into their relative contributions.

D'Argembeau et al. (2010) investigated component processes supporting episodic future thinking using various measures of executive functioning, visuospatial and relational memory processing, self-consciousness (i.e., tendency to focus attention on one's inner experiences), and time perspective (i.e., awareness of temporal direction). Participants imagined specific future episodes (specificity task), generated as many

future episodes as possible within one minute (fluency task), and constructed detailed future events and rated their phenomenological quality (details task). Their results showed that executive functioning was a significant predictor of event specificity, number of episodic details, and episodic fluency. Further, the number of sensory descriptions was predicted by visuospatial processing abilities and time perspective, while the subjective feeling of pre-experiencing was predicted by self-consciousness. These results also provide support to the idea that episodic mental time travel depends on multiple component processes that relates to its different characteristics.

Examining the underlying basis of impaired mental time travel ability in autism spectrum disorder, Lind et al. (2014) compared adults with and without autism spectrum disorder on autobiographical memory, episodic future thinking, scene construction, and theory of mind. Participants recalled personally experienced past events, envisioned plausible future scenarios, and constructed non-self-relevant fictitious experiences. They found that mental time travel impairments in autism spectrum disorder were related to scene construction rather than self-projection, as participants with autism spectrum disorder performed poorly at constructing fictitious scenes that do not involve self-projection, in addition to remembering the past and imagining the future. Similarly, Lind et al. (2013) investigated the relationship between episodic memory, episodic future thinking, theory of mind, and navigation in autism spectrum disorder. Participants completed a navigation task in which they virtually navigated through an island to find hidden objects, episodic memory and future thinking tasks by providing descriptions of past and future events in response to cue words, and finally, a theory of mind task that required them to describe intentions of animated figures. Their results showed that participants with autism spectrum disorder performed poorly on the navigation task, and

their performance was positively associated with theory of mind and episodic memory. This finding supports the idea of self-projection, as the scene construction theory does not imply that navigation ability should be related to theory of mind. However, whether the relationships between these constructs are similar in the general population is still largely unclear.

Finally, Clark et al. (2019) investigated the relationship between autobiographical memory, episodic future thinking, and scene construction by asking participants to recall autobiographical memories, imagine future episodes, and construct fictitious scenes. Their results supported the scene construction theory, as the relationship between autobiographical memory internal details and episodic future thinking experiential index was mediated by scene construction, while autobiographical memory was not a significant mediator in the relationship between other cognitive functions.

1.4 Present study

As research on the cognitive processes underlying episodic mental time travel focused solely on autobiographical recall and future thinking, it is still unclear whether the proposed mechanisms (i.e., episodic memory, scene construction, and self-projection) are equally important in the current conceptualization of episodic mental time travel. Addressing episodic counterfactual thinking within the context of the existing theoretical propositions offers some important insight into the characterization of episodic mental time travel. To our knowledge, no empirical study investigating the relative contributions of these cognitive processes to episodic mental time travel has been published. Understanding this relationship also contributes to current theoretical debates

on the cognitive basis of episodic mental time travel and autobiographical memory in general. Extending the idea of the basic-systems model of autobiographical memory (Rubin, 2006), the present study is also the first to assess the role of visual imagery as a component process in episodic mental time travel. Thus, the main aim of the present study was to examine the role of episodic memory, scene construction, self-projection, and visual imagery in the autobiographical recall, episodic future thinking, and episodic counterfactual thinking.

Importantly, the present study employed an individual-differences approach. As described in D'Argembeau et al. (2010), this approach holds the premise that the relationship between a cognitive function and its underlying mechanisms can be examined by investigating the relationship between individual differences in that cognitive function and individual differences in the mechanisms thought to underlie it. Therefore, in the current study, episodic memory was conceptualized as a trait-like tendency that characterizes the way an individual typically recalls past experiences rather than the process by which a particular past episode is represented in mind. This conceptualization is consistent with the view that there are stable individual differences in episodic memory capacity (Berntsen et al., 2019; Palombo et al., 2013; Rubin, 2021). For instance, it has been shown that reliving and vividness of and belief in an autobiographical memory can be predicted by coherence and visual and auditory characteristics of another autobiographical memory (Rubin, 2021). Thus, if episodic memory supports episodic mental time travel by providing its necessary ingredients (Schacter & Addis, 2007a), individual differences in trait episodic memory should be associated with differences in episodic mental time travel. Similarly, if the abilities to construct complex scenes (Hassabis & Maguire, 2007; Rubin & Umanath, 2015), form

vivid mental images (Rubin, 2006), and adopt alternative perspectives (Buckner & Carroll, 2007) support episodic mental time travel, individual differences in these cognitive mechanisms should also be related to differences in the characteristics of past, future, and counterfactual events.

We addressed these questions through asking our participants to retrieve autobiographical events, imagine future episodes, and construct counterfactual scenarios, rate their phenomenological quality, and complete measures of cognitive processes thought to underlie episodic mental time travel (i.e., episodic memory, scene construction, self-projection, and visual imagery). We were particularly interested in the relationship between these cognitive processes and the phenomenological quality and episodic details of recalled and imagined events, as they concern two important but distinct aspects of recalled and imagined events. While the phenomenology refers to the experience that brings personally experienced or imagined events to life with a feeling of experiencing (Tulving, 2002), episodic details relate to contextually specific features of the event narratives (Levine et al., 2002). Thus, we examined not only how these events are subjectively experienced but also the degree to which they are recalled or imagined with episodic information. This approach also allowed us to investigate possible distinctions between subjective and objective (i.e., coded by independent raters) facets of remembering and imagining.

In autobiographical memory literature, there are two widely used techniques for memory elicitation: the cue-word method, which presents participants with word cues to guide retrieval (e.g., tree), and the special-memory method, which requires them to recall certain types of memories (e.g., the happiest memory). While word-cued memories are generally of mundane events, special memories comprise significant

events that are recalled and reported with greater number of details (Demiray, 2018). Similarly, D'Argembeau et al. (2012) demonstrated that the special-memory method can also be adapted to future thinking tasks, as individuals imagined significant and important future events that reflects their identity with ease. Therefore, in the present study, we framed these past, future, and counterfactual events as "the most important" ones so that participants would be able to recall and imagine richly encoded and constructed events with as much detail as possible (for details, see Method).

Our hypotheses regarding the role of these cognitive functions were based on the existing theoretical propositions: If any of these processes underlie episodic mental time travel, they should relate to the characteristics of its different constellations (i.e., autobiographical memory, episodic future thinking, and episodic counterfactual thinking). We expected that visual imagery and self-projection would be more involved in the subjective experience of recalled and imagined events, as they are assumed to provide the sense of experiencing (Rubin, 2006) and mental time travel (Buckner & Carroll, 2007). Similarly, we hypothesized that episodic memory and scene construction would particularly relate to the number of episodic details found in event narratives by providing the contextual and spatial elements for their construction (Schacter & Addis, 2007a; Hassabis & Maguire, 2007).

CHAPTER 2

METHOD

2.1 Participants

The required sample size for the present study was calculated using G* Power 3.1 (Faul et al., 2009). For multiple regression analyses involving four predictors, G*Power suggested a sample size of 85 to detect a medium effect size (f^2 =.15) with .80 statistical power at .05 alpha level. Consequently, we collected data from 86 young adults who were undergraduate students at Boğaziçi University. Participants received partial course credits in return for their participation. Three participants were removed from the analyses for not providing counterfactual events. This led to a final sample of 83 participants (41 females and 42 males), whose ages ranged between 18 and 25 with a mean of 20.15 (*SD* = 1.38).

2.2 Measures

2.2.1 Event description task

Participants were asked to recall the most important event they have experienced in the past (autobiographical recall), imagine the most important event they might plausibly experience in the future (episodic future thinking), and imagine the most important event that could have happened in the past but did not (episodic counterfactual thinking). To minimize the effect of temporal distance, they were instructed that the events they recall or imagine should come from the last (or next) ten years. The specific instructions for the events were as follows: “Please recall (imagine) the most important event that you have experienced (would experience/could have experienced) in the last (next) ten years.

This event should have the following characteristics: A single occurrence that you can recall (imagine) clearly, which took place (might take place/might have taken place) at a specific time and place without exceeding one full day. Please write the event that fits this description in as much detail as possible by using the space provided below". For counterfactual events, based on the results of a pilot testing, they were further instructed that it was expected from them to describe the alternative scenario they imagine rather than describing the period or the moment in time when this event was likely to happen. Participants were given as much space as needed to write the event descriptions (for details of the instructions, see Appendix A).

2.2.2 Measures of event characteristics

2.2.2.1 Phenomenology

Phenomenological experience associated with each event (i.e., autobiographical event, future event, and counterfactual event) was measured by constructing a 6-item form adapted from the Autobiographical Memory Questionnaire (Rubin et al., 2003b), the Memory Experiences Questionnaire (Sutin & Robins, 2007), and Rubin (2020).

The questions assessed *feeling of experiencing* ("I am reliving the original event"), *vividness* ("I can see it in my mind"), *sensory details* ("This event involves a lot of sensory information (sound, touch, smell, taste)"), *spatial* ("I know the spatial layout"), *coherence* ("It comes to me as a coherent story"), and *content* ("I can identify the actions, objects, setting, and/or people that are involved in the event").

Participants were asked to indicate their level of agreement to statements on a 5-point Likert scale ranging from "1 = strongly disagree" to "5 = strongly agree" (for the Turkish version of the scale, see Appendix B).

2.2.2.2 Details

The degree of detail of each event description was coded according to the Autobiographical Interview scoring protocol (AI; Levine et al., 2002). The AI distinguishes between episodic and semantic aspects of autobiographical recall and classifies details in a narrative as *internal* and *external* by segmenting them into informational detail units. A unit is a grammatical clause that expresses a specific occurrence, thought, or observation (e.g., "I took the university entrance exam").

For each event description, first, the main event was identified. If multiple events were described or the main event appeared ambiguous, the event involving the shortest duration and most details was selected as the main one. Then, episodic elements of the descriptions that are directly related to the main event were classified as internal details, and those reflecting semantic knowledge that might or might not be related to the main event were classified as external details.

Internal details were further assigned into one of five mutually exclusive categories: *event* (happenings, weather conditions, and individuals present and their reactions), *time* (temporal dynamics of the event including the year, month, and day), *place* (the location at which the event took place, such as the city, room, and part of the room), *perceptual* (sensory details, such as auditory, visual, and duration), and *thought/emotion* (internal feelings and thoughts). For instance, "I was stressed by the noise when I took the university entrance exam on 18 June at the Istanbul Technical University" contains details regarding thought/emotion (feeling stressed), event (taking the university entrance exam), time (18 June), place (Istanbul Technical University), and perceptual (noise).

Likewise, external details were arranged into four categories: *external event* (specific details that are not related to the main event), *semantic* (factual and general information that is not related to a specific episode in the past), *repetition* (unwanted iterations of details), and *other* (metacognitive statements). For instance, "I usually perform poorly under stress, and I had taken my last mock exam in a noisy classroom as well" contains semantic information (performing poorly under stress) and details from an external event (last mock exam). Finally, the number of details of each type was tallied to calculate internal and external composite scores.

The author coded all event descriptions by utilizing the semi-automated scoring procedure developed by Wardell et al. (2021). It should be noted that this procedure slightly differs from the original AI, which also assigns experimenter ratings to each internal detail category, time integration, and episodic richness. Thus, no experimenter rating was given to detail categories. Following this protocol, internal and external details found in each narrative were tagged using keyboard shortcuts in Microsoft Word, and they were counted using a Python script (https://github.com/cMadan/scoreAI). 50% of the data (n = 43 participants, 129 individual events) were also coded by two research assistants who were blind to the aims of the study. Interrater agreement for total episodic details was checked using Intraclass correlation coefficients with a two-way random model for absolute agreement. For autobiographical and counterfactual events, the average measures of ICC indicated good-to-excellent agreement (.82 and .97 for autobiographical and .75 and .95 for counterfactual events). Similarly, the average measures of ICC for future events indicated excellent agreement, yielding the values of .93 and .95.

2.2.3 Measures of cognitive processes

2.2.3.1 Scene Construction Task

Individual differences in scene construction ability were measured using a modified version of the scene construction task developed by Hassabis et al. (2007), which includes imagination of atemporal fictitious experiences.

Participants were instructed that they would be presented with cues about commonplace settings and be asked to imagine vivid scenes in their mind's eye by using all available sensory information, including but not limited to sight, hearing, and smell. They would then describe their mental representation in as much detail as possible. The instructions also highlighted that they should imagine an entirely new scene that they have never experienced before instead of recalling an actual memory. It should be noted that while the original task used by Hassabis et al. (2007) is composed of imagination of six scenes, to avoid fatigue effect, participants in the present study were asked to construct only three of them (for a similar adaptation, see Madore et al. 2019). Scene cues used in the present study were beach ("Imagine you're lying on a deserted white sandy beach in a beautiful tropical bay"), museum ("Imagine you're standing in the busy main hall of a museum containing many impressive exhibits"), and street market ("Imagine you're standing in the middle of a bustling street market"). All participants received the scene cues in the same order (beach, museum, street market).

For each scene, participants were first presented with the cue, and the cue remained on the screen during the description stage. As the study was conducted on a computer, participants did not receive any prompt other than the cue itself. After each scene description, they provided two ratings regarding the perceived salience of the scene ("How vivid was the scene you imagined in your mind's eye?") and their sense of

presence ("How much of a sense of being there did you have when imagining?") on a 5-point Likert scale. They were also presented with the spatial coherence index, which includes 12 qualitative statements that describe how integrated and fragmented their mental representation was. Eight of these statements involved descriptions of an integrated and contiguous scene (e.g., "I would find it easy to give further details of the surroundings in the scene"), while the remaining four described a fragmented and non-contiguous one (e.g., "I could see individual details, but it didn't all fit together as a whole scene"). Participants were instructed to check off the statements that best describe their experience during scene construction (for the Turkish version of the task, see Appendix C).

The scene descriptions were then scored according to the guidelines established by Hassabis et al. (2007). The outcome measure, the *experiential index*, which indicated the overall richness of the description and ranged from 0 to 60, was calculated for individual scenes and then averaged to form a composite task score. The experiential index included subcomponents of content, participant ratings, spatial coherence, and quality judgment.

Each scene description was segmented into informational units, and these statements were then assigned into one of four categories: *spatial reference* (relative position of entities within the scene), *entity presence* (count of mentioned objects, people, and animals), *sensory description* (sensory descriptions of entities and weather conditions) and *thought/emotion/action* (introspective thoughts and feelings and actions of other entities). Details that cannot be classified into one of these categories and repeated statements were eliminated. As argued by Hassabis et al. (2007), the production of 7 details per category was treated as the reflection of optimal performance. Therefore,

the maximum score that can be obtained from each subcategory was 7, and the total possible content score was 28. Participant ratings of sense of presence and perceived salience were rescaled from the original 5-point Likert scale to range between 0 and 4. Thus, they together yielded scores between 0 and 8. Similarly, the spatial coherence index score was calculated using the statements which were selected by participants to describe their experience during scene construction. One point was added for each integrated statement, and one point was subtracted for each fragmented statement, yielding a score between -4 and +8. This score was then normalized around zero, and the final spatial coherence index score ranged between -6 and +6. Constructions with a positive spatial coherence index were considered coherent, while those with a negative index were incoherent. As advised by Hassabis et al. (2007), only the positive scores contributed to the experiential index to avoid the over-penalization of fragmented constructions. Finally, the quality judgment rating was given by the scorer to assess the overall quality of the scene construction based on the extent to which the description evokes a detailed scene in their own mind's eye. The quality judgment was rated on a scale ranging from "0 – no picture at all" to "10 – extremely vivid picture". In this sense, the score of 0 reflected a scene that lacked details and feeling of experiencing, while the score of 10 indicated that the construction was extremely rich and detailed. These scores were then multiplied by 1.8 and thus yielded a score between 0 and 18.

The author coded the scene descriptions using an adapted version of the semi-automated procedure of Wardell et al. (2021). For this purpose, content categories were tagged using keyboard shortcuts in Microsoft World and the Python script was modified for the scene construction task.

2.2.3.2 Interpersonal Reactivity Index

The Interpersonal Reactivity Index (IRI; Davis, 1980) is a 28-item measure of empathic tendency and is composed of four subscales that assess its cognitive and affective components: Perspective Taking, Empathic Concern, Fantasy, and Personal Distress.

In the present study, the Perspective Taking subscale was used to measure individual differences in self-projection, as the cognitive aspects of empathy and theory of mind were found to be related to each other (for a review, see Dvash & Shamay-Tsoory, 2014). The subscale involves seven items and assesses the tendency to spontaneously imagine others' psychological points of view (e.g., "I sometimes try to understand my friends better by imagining how things look from their perspective"). In addition to the Perspective Taking subscale, to avoid response bias, we included six filler items from the other three subscales of the IRI (for the full list of items, see Appendix D).

Participants indicated their level of agreement with the statements on a 5-point Likert scale ranging from "1 = does not describe me well" to "5 = describes me very well". The total score is calculated by averaging the ratings of the subscale items. The subscale had acceptable reliability (Cronbach's αs were .78 for females and .75 for males; Davis, 1980). In the current sample, Cronbach αs were .60 and .70 for females and males, respectively (for the whole sample, α = .67).

2.2.3.3 Autobiographical Recollection Test

Individual differences in episodic memory were measured using the Brief Autobiographical Recollection Test (the Brief ART; Berntsen et al., 2019; Ece et al., 2021). Unlike the long version, the Brief ART has a single-factor solution and measures

the trait-like individual differences in how well individuals remember their past experiences. Thus, higher scores indicate the tendency of the individual to recall their past well in general.

The scale assesses this tendency in autobiographical recollection on *vividness* ("My memories of past events have lots of details"), *coherence* ("My memories of past events come to me as good stories or descriptions"), *reliving* ("While remembering past events, it is as if I am reliving them"), *rehearsal* ("I often think back to past events in my mind and think or talk about them"), *scene* ("In my memories of past events, I remember where the actions, objects, and people are located in the events"), *visual* ("While remembering past events, I can see them in my mind"), and *life story* ("My memories of past events are a central part of my life story", for the Turkish version of the scale, see Appendix E).

Participants rated their level of agreement with these statements on a 7-point Likert scale anchored by "1 = strongly disagree" to "7 = strongly agree". The total score is obtained by calculating the scale mean. The scale had acceptable reliability in the current sample (Cronbach's α = .75).

2.2.3.4 Plymouth Sensory Imagery Questionnaire

The Plymouth Sensory Imagery Questionnaire (Psi-Q; Andrade et al., 2014) measures mental imagery across different sensory modalities: Vision, Sound, Smell, Taste, Touch, Bodily Sensation, and Emotional Feeling. While the long version of the scale includes 35 statements, the short form of the Psi-Q involves 21 items.

In the present study, only the short version of the Appearance subscale was used to measure individual differences in visual imagery. The subscale involves three

scenarios (a bonfire, a sunset, and a cat climbing a tree), and participants were required to imagine each of them and rate the generated mental image on an 11-point Likert scale ranging from "0 = no image at all" to "10 = as vivid as real-life" (for the Turkish version of the scale, see Appendix F). The total score is calculated by averaging the ratings for each scenario. The questionnaire had excellent reliability (Cronbach's α = .97 for the whole scale; Andrade et al., 2014). In the current sample, the Cronbach's α for the subscale was .23.

2.3 Procedure

The study was approved by the Boğaziçi University Ethics Committee for Master and Ph.D. Theses in Social Sciences and Humanities (see Appendix G). Of the total sample, 78 participants were tested in a laboratory setting, while the remaining 5 completed the study via Zoom (Zoom Video Communications Inc., 2016). Participants were tested individually in a single session. All study materials were provided to participants through Qualtrics (Qualtrics, Provo, UT), an online survey medium, on a computer. Thus, the study was self-paced and took approximately an hour to complete. Before the session started, informed consent was obtained from participants, and they were informed about the procedure by the experimenter.

Participants first completed the event description task consisting of autobiographical recall, episodic future thinking, and episodic counterfactual thinking. The order of these event descriptions was counterbalanced across participants. Following each event description, they answered the phenomenological experience questions and indicated the age at which the event took place in the past/might take place in the future/might have taken place in the past.

After the event description task, participants completed the remaining measures in the following order: the Scene Construction Task, the Perspective Taking subscale of the IRI, the Brief ART, and the Appearance subscale of the Psi-Q. The task order was organized as described to avoid possible interference between the tasks involving similar procedures (e.g., both the Scene Construction Task and the Psi-Q require participants to form a mental image). At the end of the session, participants filled out the demographic information form and were debriefed about the study (for details, see Appendix H).

CHAPTER 3

RESULTS

The results were presented under three subheadings: We first report the descriptive statistics for the measures of event characteristics and cognitive processes. Next, we conducted principal component analyses (PCAs) for phenomenological quality ratings to examine whether they can be reduced to a smaller number of components describing the subjective experience. We also conducted a series of correlation analyses to investigate the relationships between event characteristics and cognitive processes. Finally, we performed multiple regression analyses to test the hypothesized relationships between episodic mental time travel and episodic memory, scene construction, self-projection, and visual imagery.

3.1 Descriptive statistics of event characteristics and cognitive processes

The means and standard deviations, as well as the mean differences for phenomenology and episodic details across event types, are presented in Table 1. For phenomenology ratings, Bonferroni corrected pairwise comparisons showed that autobiographical events had richer phenomenological quality compared to future and counterfactual events across all dimensions, and future events were accompanied by a greater sense of experiencing than counterfactual events. Further, counterfactual events involved a clearer spatial organization compared to future events. These results are consistent with the previous studies demonstrating phenomenological differences between past and future episodic mental time travel (Branch & Zickar, 2020; İkier et al., 2022; Özbek et al., 2017, 2018, 2020).

Table 1. Descriptive Statistics for the Event Characteristics Across Event Types

	Autobiographical Event		Future Event		Counterfactual Event			
Characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	PC
Phenomenology								
Experiencing	3.95	1.15	3.20	1.34	2.77	1.50	24.10*	A > F > C
Vividness	4.81	.53	4.42	.81	4.43	.83	9.43*	A > F, C
Sensory Details	4.11	1.22	3.35	1.41	3.47	1.34	11.30*	A > F, C
Spatial	4.76	.58	3.55	1.38	4.22	1.15	30.06*	A > C > F
Coherence	4.52	.85	4.02	1.01	4.11	.95	8.51*	A > F, C
Content	4.70	.60	3.78	1.21	4.18	1.10	19.43*	A > F, C
Details								
Total Episodic	23.98	18.69	15.15	12.60	16.52	14.60	18.28*	A > F, C
Event	14.49	11.68	9.00	7.52	11.00	9.21	15.15*	A > F, C
Perceptual	2.84	3.93	1.98	3.06	1.45	2.96	7.19*	A > C
Place	1.89	2.11	1.39	1.47	1.40	1.96	2.87	NS
Time	1.18	1.15	.51	.83	.83	1.03	11.88*	A, C > F
Thought/ Emotion	1.18	3.20	2.28	3.55	1.84	2.64	9.85*	A > F, C

Note: *df* (degrees of freedom numerator, degrees of freedom denominator) = 2,164, except for vividness (1,149), content (1,133), and episodic event detail (1,148). * indicates significant differences at .05 level. Abbreviations: PC = Pairwise comparisons, A = Autobiographical event, F = Future event, C = Counterfactual event, NS = Nonsignificant pairwise comparison.

In terms of the number of episodic details, pairwise comparisons showed that autobiographical event narratives contained more episodic details from each category compared to future and counterfactual events. Counterfactual event narratives involved more time details than future events, and perceptual details included in future event descriptions were significantly different from those involved in neither autobiographical nor counterfactual event narratives. These findings also corroborate with the existing literature on the differences between narrative characteristics of past, future, and counterfactual events (Addis et al., 2008; De Brigard et al., 2017).

The means with 95% confidence intervals and standard deviations for the Brief ART, the Scene Construction Task, the Perspective Taking subscale of the IRI, and the Appearance subscale of the Psi-Q are presented in Table 2. Participants scored above the midpoint of each scale. Of the correlations among these four measures, the only significant correlation was between the Perspective Taking subscale of the IRI and the Appearance subscale of the Psi-Q (r = .28, p = .01).

Table 2. Descriptive Statistics for the Measures of Cognitive Processes

Measures	M	Lower CI	Upper CI	SD
The Brief ART	5.44	5.25	5.62	.86
The Scene Construction Task	31.64	30.11	33.18	7.03
The Perspective Taking subscale of the IRI	2.54	2.41	2.67	.59
The Appearance subscale of the Psi-Q	7.96	7.71	8.21	1.13

Next, we calculated the temporal distance of each event by subtracting ages-at-event from participants' current ages for autobiographical and counterfactual events and by subtracting participants' current ages from age-at-event for future events to obtain positive numbers. The mean temporal distance was 2.95 (SD = 2.33) for autobiographical, 5.50 (SD = 2.60) for future, and 3.52 years (SD = 2.45) for counterfactual events. There was a significant difference between temporal distances of events, $F(2,164) = 23.70$, $p < .001$. Bonferroni corrected posthoc comparisons indicated that future events had a greater distance from the present compared to autobiographical and counterfactual events (both ps < .001). Figure 1 depicts the distribution of temporal distances in years.

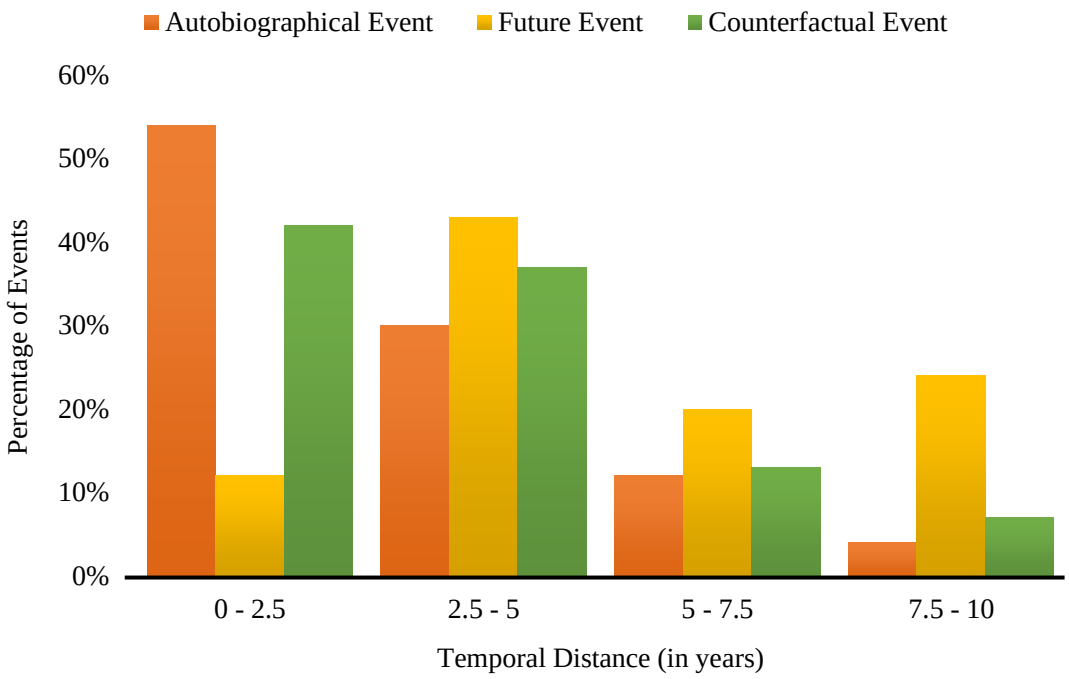

Figure 1. Distribution of the temporal distances across event types

As shown in Figure 1, autobiographical and counterfactual events were largely coming from the near past, while future events were expected to be experienced in a more distant future. Although we did not conduct such coding, this might be related to the content of future events, as most of the participants described events related to graduation, marriage, moving abroad, and starting one's first job, which is expected to take place during the mid-twenties according to the Turkish cultural life script (Erdoğan et al., 2008; Tekcan et al., 2012).

3.2 Principal component analyses for event characteristics

Before conducting the main analyses, we carried out nonrotated principal component analyses (PCAs) to reduce the phenomenological experience questions to a smaller set of components. Table 3 shows the Pearson correlations between the phenomenological

characteristics of each event type. These correlations indicated that these phenomenological experience dimensions might be reduced to components that adequately represent the data.

Table 3. Correlations Between the Phenomenological Characteristics

Characteristic	1	2	3	4	5	6
Autobiographical Event						
1. Experiencing	1					
2. Vividness	.21	1				
3. Sensory Details	.19	.35**	1			
4. Spatial	.20	.21	.04	1		
5. Coherence	.27*	.39***	.32**	.08	1	
6. Content	.30**	.39***	.21	.25*	.36**	1
Future Event						
1. Experiencing	1					
2. Vividness	.40***	1				
3. Sensory Details	.29**	.39***	1			
4. Spatial	.36**	.52***	.49***	1		
5. Coherence	.19	.37**	.23*	.35**	1	
6. Content	.31**	.35**	.50***	.61***	.27*	1
Counterfactual Event						
1. Experiencing	1					
2. Vividness	.40***	1				
3. Sensory Details	.43***	.49***	1			
4. Spatial	.26*	.37***	.37**	1		
5. Coherence	.43***	.42***	.32**	.48***	1	
6. Content	.14	.38***	.26*	.48***	.33**	1

Note: *, **, and *** indicate significant Pearson correlations (r) at .05, .01, and .001 levels, respectively.

In the analyses, components with eigenvalues larger than 1 were extracted. Bartlett's test of sphericity and Kaiser-Meyer-Olkin measure of sampling adequacy suggested that using PCA was appropriate ($\chi^2(15) = 64.26$, $p < .001$ and .75 for

autobiographical events, $\chi^2(15) = 125.87$, $p < .001$ and .81 for future events, and $\chi^2(15) = 120.83$, $p < .001$ and .78 for counterfactual events). Thus, we proceeded with the analyses, and the factor loadings yielded by these analyses are presented in Table 4.

Table 4. Factor Loadings of Phenomenological Experience Questions

	Autobiographical Event		Future Event	Counterfactual Event
Characteristic	Factor 1	Factor 2	Factor 1	Factor 1
Experiencing	.56		.59	.63
Vividness	.73		.73	.75
Sensory Details	.58	-.51	.71	.69
Spatial		.76	.82	.72
Coherence	.69		.54	.73
Content	.71		.75	.61

Note: Loadings smaller than .30 were suppressed.

For autobiographical events, the analysis revealed two components that account for 55.76% of the total variance. The first component included positive loadings from all items except the spatial, forming an index of *overall phenomenological quality*. The second component included a positive loading from spatial and a negative cross-loading from sensory details, which can be considered an index of *spatial characteristics*. For future and counterfactual events, the analyses extracted only one component that accounts for 48.68% and 47.71% of the total variance, which were considered indices of *overall phenomenological quality*. Factor scores were calculated using the regression method, and the following analyses were conducted using these standardized scores.

This difference between components of presumably experienced and imagined events might indicate the unique role of spatial processing in autobiographical memory that represents a distinct aspect of the recollective experience. A similar pattern was also

obtained by Fitzgerald and Broadbridge (2013), as their latent constructs analysis of the Autobiographical Memory Questionnaire indicated that spatial characteristics were related to the belief in memory, while the other phenomenological dimensions were associated with the recollective experience.

3.3 Correlations among event characteristics and cognitive processes

To examine the relationships between event characteristics and cognitive processes, we first conducted a series of correlational analyses for autobiographical, future, and counterfactual events separately.

For autobiographical events, visual imagery correlated with the overall phenomenological quality (r = .30, p = .01) and scene construction was related to number of episodic details (r = .31, p = .01). The other correlations were nonsignificant (ps > .05). In terms of future events, episodic memory correlated with the overall phenomenological quality (r = .33, p = .003) and the remaining correlations yielded nonsignificant results (ps > .05). For counterfactual events, interestingly, none of the cognitive processes were significantly related to event characteristics (all ps > .05).

These results indicate that the relative contributions of the cognitive processes included in the present study might differ across the modes of episodic mental time travel and within the characteristics of each event type.

3.4 Relationships between event characteristics and cognitive processes

To examine the role of episodic memory, scene construction, self-projection, and visual imagery in episodic mental time travel, we performed multiple regression analyses predicting the characteristics of autobiographical, future, and counterfactual events.

All predictors were entered into the regression models simultaneously. We first checked the assumptions of multiple linear regression to see whether proceeding with the analyses is justified. Across the regression models for each event type, the relationships between event characteristics and cognitive processes were linear, with no multicollinearity and significant outliers in the data and no relationship between error terms which were also approximately normally distributed.

For autobiographical events, the model predicting the overall phenomenological quality was significant, $F(4,78) = 3.06$, $p = .02$, with an R^2 value of .14. However, the model on the spatial characteristics was not significant, $F < 1.00$. In terms of episodic details, the model explained 11% of the variability, $F(4,78) = 2.52$, $p = .05$.

For future events, the model predicting the overall phenomenological quality was significant, $F(4,78) = 2.79$, $p = .03$, with an R^2 value of .13. However, the model for episodic details was nonsignificant, $F < 1.00$.

For counterfactual events, models for both the overall phenomenological quality and episodic details were not significant ($F(4,78) = 1.48$, $p > .05$ for phenomenology and $F < 1.00$ for episodic details). Unstandardized β weights of these analyses are presented in Table 5.

These results supported the idea that the relationships between episodic mental time travel and cognitive processes included in the present study differs across event types and characteristics, as each predictor except self-projection predicted a different characteristic of past and future episodic mental time travel.

Table 5. Unstandardized B Weights of Cognitive Processes

Characteristic	Scene Construction	Episodic Memory	Self-projection	Visual Imagery
Autobiographical Event				
Overall Phenomenology	.02	.12	.16	.23*
Spatial Characteristics	.02	.01	-.28	.11
Episodic Details	.85**	-2.30	3.25	-.93
Future Event				
Overall Phenomenology	<.001	.37**	-.02	.12
Episodic Details	.26	.73	-1.06	.46
Counterfactual Event				
Overall Phenomenology	.01	.13	.31	.04
Episodic Details	.32	.16	-.08	-.49

Note: * and ** indicate significant β weights at .05 and .01 levels, respectively.

These analyses revealed that scene construction, visual imagery, and episodic memory independently contributed to the prediction of the characteristics of autobiographical and future events, respectively. Scene construction was the only significant predictor of the number of episodic details found in autobiographical narratives, while visual imagery was of the overall phenomenological quality. Further, episodic memory independently predicted the overall phenomenological quality of future events. None of the processes predicted the characteristics of counterfactual events, spatial characteristics of autobiographical events, and episodic details found in future event narratives. Finally, self-projection was not a significant predictor of any characteristics across the event types. Importantly, these results did not change even when self-projection was not included in the analyses.

CHAPTER 4

DISCUSSION

The present study aimed to examine the cognitive processes underlying episodic mental time travel. We addressed this question by investigating the relative contributions of scene construction, episodic memory, self-projection, and visual imagery to the prediction of characteristics of autobiographical, future, and counterfactual events. Our results showed that scene construction, episodic memory, and visual imagery underlie different aspects of past and future mental time travel, as scene construction predicted the number of episodic details found in autobiographical event narratives, while the others independently contributed to phenomenological experience accompanying autobiographical and future events. We discuss our findings in more detail below based on the modes of episodic mental time travel.

4.1 Autobiographical memory

Consistent with our expectation, visual imagery independently predicted the overall phenomenological quality, the component that includes all dimensions except the spatial, of autobiographical events. This result suggests that the ability to form vivid mental images plays a crucial role in reliving personal memories with a rich subjective experience, over and above scene construction, episodic memory, and self-projection. This finding also supports the basic-systems model of autobiographical memory (Rubin, 2005, 2006) and is in line with the previous reports on the relationship between visual imagery and autobiographical memory (Aydın, 2018; D'Argembeau & Van der Linden, 2006; Greenberg & Knowlton, 2014; Greenberg & Rubin, 2003; Rubin et al., 2003a;

Rubin et al., 2003b; Swann & Miller, 1982; Vannucci et al., 2016; for a recent review, see Sheldon, 2022). Importantly, our conceptualization of visual imagery and how we chose to measure it (i.e., the Appearance subscale of the Psi-Q) might be the factors driving this association. It is now well-established that visual imagery is a multifaceted construct that involves the object and spatial components (Hegarty & Kozhevnikov, 1999; Kozhevnikov et al., 2005). In this vein, object imagery entails the process by which visual aspects of objects and scenes (e.g., size and color) are represented in the mind, while spatial imagery refers to the ability to process schematic representations and spatial relations between objects (Blajenkova et al., 2006). As the Psi-Q measures the former, forming a vivid representation of the event and seeing it in the mind's eye can underlie the experience that the recalled episode is relived with a strong sense of experiencing rather than the feeling that the spatial layout of the event is known. This distinction can also explain why the spatial properties of autobiographical events, which might depend more on spatial imagery abilities, were not predicted by any of the independent variables included in the present study. A future study focusing more on the role of spatial imagery is therefore recommended.

Another important finding from the present study was the relationship between scene construction and episodic details. In line with our hypothesis, scene construction uniquely contributed to the prediction of the number of episodic details found in autobiographical narratives. This finding corroborates with the scene construction theory and provides further empirical support for the idea that the process of forming multimodal spatial scenes might be the underlying mechanism of episodic mental time travel (Hassabis et al., 2007; Hassabis & Maguire, 2007). As scene construction is characterized by the process by which semantic, sensory, and contextual components are

retrieved and integrated into a coherent spatial context (Hassabis & Maguire, 2009), it can support retrieving specific episodic details (e.g., people, happenings, and sensory details) about an autobiographical episode to construct a coherent narrative of the event. Autobiographical knowledge is thought to be organized in a hierarchical structure that determines the degree to which the recalled event contains specific episodic details (Conway & Pleydell-Pearce, 2000). At the most abstract level, autobiographical knowledge might be represented as lifetime periods that include thematic and temporary knowledge about the features and duration of the distinct periods in time (e.g., when I was at college). At the next level of specificity, they can also be represented as general events that involve repeated or single events that are thematically related to each other (e.g., final exams). Finally, autobiographical knowledge might be represented as detailed as event-specific knowledge, which refers to vivid bits of information pertaining to a specific episode (e.g., the day of the graduation ceremony, Conway, 1996; Conway & Rubin, 1993). Within this context, scene construction might contribute to the retrieval process by setting the scene for the content that increases the accessibility of event-specific knowledge, thereby resulting in facilitated recollection of episodic details of the past. This finding is also in line with the propositions of the event memory account (Rubin & Umanath, 2015). In his dimensional model, Rubin (2019, 2022) situates autobiographical memories in general memory organization as the explicit self-referent event memories, which are explicitly remembered, represented in relation to self, and aided by scene construction during recall. In this regard, forming multimodal complex scenes might be a prerequisite for representing richly encoded and retrieved autobiographical memories in the mind and producing autobiographical narratives soaked in episodic details. However, we note that this finding needs to be interpreted

with caution as the regression model on the relationship between episodic details and cognitive processes included in the present study only approached significance (p = .05).

Contrary to our hypothesis, individual differences in episodic memory did not predict the phenomenology and episodic details of autobiographical memories. Although it has been shown that stable individual differences exist in how well individuals remember their past experiences, which meaningfully relates to their semantic and spatial memory abilities (Berntsen et al., 2019), there have been very few empirical examinations into the relationship between these trait-like episodic memory abilities and the number of episodic details found in specific autobiographical narratives. Investigating the relationship between trait mnemonics (i.e., episodic, semantic, spatial, and future) and the episodic details of autobiographical narratives, Palombo et al. (2012) reported a similar finding as the number of episodic details found in autobiographical narratives was only predicted by spatial memory abilities, which might relate to scene construction measure in the present study. A possible explanation for this unexpected finding might be the nature of elicited memory type, as our participants recalled and reported autobiographical memories of the most important events they have experienced. These special events might represent a boundary condition that is independent of how one typically remembers their past. Future research might examine this possibility by eliciting different types of events or using the cue-word method. Importantly, it should be noted that we used the Brief ART, a self-report scale, to measure individual differences in episodic memory. Thus, there could also be a mismatch between participants' judgments about their episodic memory, their subjective experience of specific autobiographical memories, and the number of objectively coded episodic details they produce in narratives.

4.2 Episodic future thinking

Trait episodic memory, individual differences in how well individuals think they recall their past, was the only significant predictor of the overall phenomenological quality of future events, supporting the idea of constructive episodic simulation (Schacter & Addis, 2007a, 2007b; for a recent review, see Schacter & Addis, 2020). This result indicates that increased capacity to recall one's past supports episodic future thinking by enabling one to imagine future events with a richer phenomenological experience. A somewhat similar finding was reported by Thakral et al. (2019) when they asked participants to recall autobiographical memories, imagine future events using location and person details drawn from the past events, and rate the vividness of the details (i.e., location and person) of recalled and imagined events. They found that the vividness of imagined details relates to the vividness of these details in autobiographical memories. Thus, one possible explanation for our finding may be that episodic memory supports and enriches the phenomenological experience of future thinking by providing a database that can be used to flexibly integrate information into new future occurrences during imagination. In this sense, individuals with a higher episodic memory capacity might have more "resources" that aid the construction of future events, which strengthens the subjective experience.

Surprisingly, visual imagery and scene construction did not predict any of the characteristics of future events. This lack of significance contradicts the propositions of scene construction theory (Hassabis & Maguire, 2007) and the previous research showing that the number of sensory details and the phenomenological quality of future events can be predicted by visual-spatial processing (D'Argembeau et al., 2010), scene construction ability (Clark et al., 2019), and individual differences in visual imagery

(D'Argembeau & Van der Linden, 2006). Further, contrasting with our hypothesis and the earlier findings, the differences in trait episodic memory did not predict differences in the number of episodic details (Addis et al., 2008; Addis et al., 2010; Madore et al., 2014; Madore & Schacter, 2016). This discrepancy might be due to the content of future events. Most of the future event narratives reported by our participants were about life script events (e.g., college graduation ceremony, starting one's first job, getting into graduate school, and wedding ceremony). Life script events are thought to be semantic knowledge about culturally expected events (Berntsen & Rubin, 2004; Janssen & Rubin, 2011) and are usually composed of a set of episodes embedded in them. For instance, in a typical college graduation ceremony, individuals arrive at the avenue with their family, meet with their friends to share the excitement, take photographs, listen to the farewell speech, and throw mortarboards. This kind of scripted events may be more reliant on semantic memory capacity and less related to episodic processes, as they can be imagined with fewer details extracted from episodic memory and do not necessarily demand vivid mental imagery or construction of a scene. This idea is also important in the conceptualization of episodic future thinking since these kinds of future events lack the episodic feeling of experiencing and of details yet are not overgeneral enough to be regarded as semantic future thinking.

4.3 Episodic counterfactual thinking

One of the most important findings in the present study was the lack of association between the characteristics of episodic counterfactual events and cognitive processes. Although previous research did not concern with this relationship, and the current study was the first to do so, these nonsignificant findings contradict the existing literature on

the nature of episodic counterfactual thinking and how it relates to autobiographical memory and episodic future thinking (De Brigard & Parikh, 2019; Schacter et al., 2015). These findings indicate that episodic counterfactual thinking might not be a mode of episodic mental time travel as it cannot be addressed within the framework of the theories proposed for autobiographical memory and episodic future thinking. According to Addis (2020), memory and imagination are essentially the same process of episodic simulation that utilizes the same information stored in episodic memory, are controlled by the same associative processes, and depend on the same brain systems. Within this context, autobiographical memory, episodic future thinking, and episodic counterfactual thinking constitute the different aspects of the same neurocognitive system. Thus, the "mental" construction of experience, not the constructs of "time" and "travel", is the fundamental aspect of what has been termed episodic mental time travel (Addis, 2020). However, our results do not support this claim and suggest that “time” and “travel” might be equally important. As episodic counterfactual thinking conceptually exists outside the temporally extended dimension that covers the experienced past and imagined future (De Brigard & Parikh, 2019), these events might not constitute a form of episodic mental time travel and, thus, may not be supported by the processes that underlie autobiographical memory and episodic future thinking.

An alternative explanation might be related to the nature of episodic counterfactual thinking as a slightly more multifaceted process than autobiographical recall and episodic future thinking. Simply put, autobiographical retrieval is largely guided by elaboration and search processes during which the individual uses the cue to access autobiographical and self-related knowledge (for a review, see Conway & Loveday, 2010). Similarly, future episodes are constructed through accessing general

personal knowledge to guide imagination (D'Argembeau & Mathy, 2011). On the other hand, episodic counterfactual thinking might demand retrieval of an autobiographical event, interpretation of episodic details extracted from that specific episode, and reasoning about and imagination of alternative outcomes. This idea is consistent with neuroimaging findings, as Van Hoeck et al. (2013) found that relative to autobiographical recall, episodic counterfactual thinking increases activation in the posterior medial frontal and prefrontal cortices, the areas that are related to action monitoring, reasoning, and cognitive control. Thus, cognitive mechanisms involved in counterfactual thinking might be different from those involved in remembering the past and imagining the future, which diminishes the importance of the processes included in the present study.

In a similar vein, counterfactual events may be less frequently rehearsed and more cognitively demanding. In this vein, Branch and Zickar (2010) found that individuals engage in episodic counterfactual thinking to a much lesser extent than autobiographical recall and episodic future thinking in everyday life. Therefore, compared to autobiographical and future events, these counterfactual events might be lower in their episodic fluency, which may plausibly influence their phenomenological quality and the degree to which they involve episodic details. This possibility might also explain the dissociation between episodic counterfactual thinking and other modes of episodic mental time travel.

Finally, it also seems possible that episodic counterfactual thinking may not be as episodic as it was thought to be. In response to counterfactual thinking instructions, participants in the present study typically narrated an autobiographical event and described a possible alternative outcome about what could turn out differently, which is

consistent with the previous empirical and theoretical reports on the issue (Özbek et al., 2017; Schacter et al., 2015). Therefore, what is episodic in these event constructions is the actual experienced event (i.e., autobiographical memory), while the counterfactual part is the description of semantic knowledge, which might plausibly be guided by causal reasoning. This idea might be important in the theoretical definition of episodic counterfactual thinking and may explain why its characteristics were not predicted by processes such as visual imagery and scene construction.

4.4 The role of self-projection

We discuss our results on the contribution of self-projection to the prediction of the characteristics of autobiographical memory, episodic future thinking, and episodic counterfactual thinking in this separate section. Contrary to our hypothesis, individual differences in self-projection did not relate to the characteristics of any of the events. Although self-projection is thought to be associated with the sense of mentally traveling in time to relive a past event and imagine a future or alternative episode (Buckner & Carroll, 2007), our result suggests that it might not be a key process in episodic mental time travel. In line with our findings, comparing neuropsychological patients who display difficulties in autonoetic consciousness (i.e., conscious recollection of the past) with healthy controls on theory of mind and perspective-taking, which are widely studied forms of self-projection, Rosenbaum et al. (2007) found no difference between patients and controls in those abilities. It should be noted that, in the present study, self-projection was assessed using a measure of perspective-taking (i.e., the Perspective Taking subscale of the IRI). Although the two are separable, perspective-taking has been regarded as a form of theory of mind (Barnes-Holmes et al., 2014; Harwood & Farrar,

2006). Thus, alternatively, different forms of self-projection that directly relate to autonoetic consciousness and simulating the self along a temporal continuum, rather than perspective-taking that requires projecting oneself to others' viewpoints, might still play a role in episodic mental time travel. Future research should consider this possibility to understand the role of self-projection in episodic mental time travel.

4.5 Limitations and future research

One of the limitations of the present study was related to the size of our college sample. The results of the sensitivity analyses conducted using G* Power 3.1 (Faul et al., 2009) suggested that we were able to detect medium effect sizes (f^2 = .15) with .80 power at a .05 alpha level. When transformed to R^2, this value approximated our smallest significant effect size (R^2 = .13) and was above the largest nonsignificant effect size (R^2 = .11). Thus, future research is necessary to determine the generalizability of our findings across age groups among larger samples. Second, as the cognitive processes included in the present study were measured using self-report scales rather than performance-based tasks, there is always a possibility that these subjective measurements might be biased and not reflect the actual performance of the individual (Clark & Maguire, 2020). Future research might follow up on our results by utilizing performance-based measures to make more precise estimations. Importantly, the Appearance subscale of the Psi-Q, which was used as a measure of visual imagery, demonstrated low reliability (Cronbach's α = .23). Although the psychometric validation of the Psi-Q was established by Andrade et al. (2014), they did not report the internal consistency of each subscale. This might be related to the number of items included in each subscale (n = 3 in the subscales of the Psi-Q), as Cronbach's alpha estimates are

influenced by the number of items in the test (Sijtsma, 2009; Streiner, 2003; Vaske et al., 2017). Nevertheless, our results regarding the role of visual imagery should be interpreted with caution, and further research is needed to ascertain the reliability of our findings.

The findings of the present study also provide some empirical and theoretical questions regarding the characterization of episodic future thinking and episodic counterfactual thinking for future research to address. Future studies may examine the role of reasoning and cognitive control abilities in episodic counterfactual thinking to understand its place in the current conceptualization of episodic mental time travel. Similarly, investigating semantic and episodic memory contributions to these imagined events could be an important avenue for research. Finally, future research might also employ modeling approaches to understand how these recalled and imagined events and cognitive processes included in the present study relate to each other as a whole.

4.6 Conclusion

The purpose of the present study was to examine cognitive processes underlying episodic mental time travel by investigating the relative contributions of episodic memory, scene construction, self-projection, and visual imagery to autobiographical memory, episodic future thinking, and episodic counterfactual thinking. Our findings suggested that these cognitive processes predominantly relate to different aspects of recollection and imagination. The results showed that visual imagery was an independent predictor of the overall phenomenological quality of autobiographical memories, while scene construction was of the number of episodic details found in those autobiographical narratives. Similarly, trait episodic memory predicted the

phenomenological experience accompanying the imagination of possible future episodes. These findings indicate that visual imagery and scene construction support subjective experience and episodic detail production in autobiographical recall by providing a vivid representation of a spatial scene, and episodic memory enriches the phenomenological quality of future events by providing the database for their construction. Surprisingly, self-projection was not related to the characteristics of these past and future events, and episodic counterfactual thinking was independent of the cognitive processes included in the present study. Taken together, the present study provides empirical support for the ideas of basic-systems (Rubin, 2006), constructive episodic simulation (Schacter & Addis, 2007a), and scene construction (Hassabis & Maguire, 2007; Rubin & Umanath, 2015) and raises important theoretical and empirical questions for future research.

APPENDIX A

EVENT DESCRIPTION TASK

Autobiographical Event *(Otobiyografik Olay)*: Please recall the most important event that you have experienced in the last ten years. This event should have the following characteristics: A single occurrence that you can recall clearly, which took place at a specific time and place without exceeding one full day. Please write the event that fits this description in as much detail as possible by using the space provided below. *(Şimdi sizden, son 10 yılda yaşadığınız en önemli olayı hatırlamanızı istiyoruz. Bu anı aşağıdaki özelliklere sahip olmalıdır: Belirli bir yerde ve zamanda gerçekleşmiş ve süresi bir tam günü (24 saati) aşmayan ve net bir biçimde hatırlayabildiğiniz. Lütfen bu tanıma uygun bir anınızı mümkün olduğunca ayrıntılı biçimde, hatırladığınız tüm detayları dahil ederek aşağıda verilen boşluğu kullanarak yazınız)*

Future Event *(Gelecek Olay)*: Please imagine the most important event that you would experience in the next ten years. This event should have the following characteristics: A single occurrence that you can imagine clearly, which might take place at a specific time and place without exceeding one full day. Please write the event that fits this description in as much detail as possible by using the space provided below. *(Şimdi sizden, önümüzdeki 10 yıl içerisinde yaşamanız mümkün olan en önemli olayı hayal etmenizi istiyoruz. Bu olay aşağıdaki özelliklere sahip olmalıdır: Belirli bir yerde ve zamanda gerçekleşecek ve süresi bir tam günü (24 saati) aşmayacak olan ve net bir biçimde hayal edebildiğiniz. Lütfen bu tanıma uygun bir olayı mümkün olduğunca ayrıntılı biçimde, hayal ettiğiniz tüm detayları dahil ederek aşağıda verilen boşluğu kullanarak yazınız)*

Counterfactual Event *(Karşıolgusal Olay)*: Please imagine the most important event that you could have experienced but did not in the last ten years. This event should have the following characteristics: A single occurrence that you can imagine clearly, which might have taken place at a specific time and place without exceeding one full day. Please write the event that fits this description in as much detail as possible by using the space provided below. What is expected from you here is to describe the alternative scenario that you imagine, not the period or the moment in time when this event was likely to happen. *(Şimdi sizden, son 10 yılda yaşamadığınız ancak yaşanma ihtimali olmuş olan en önemli olayı hayal etmenizi istiyoruz. Bu olay aşağıdaki özelliklere sahip olmalıdır: Belirli bir yerde ve zamanda gerçekleşecek ve süresi bir tam günü (24 saati) aşmayacak olan ve net bir biçimde hayal edebildiğiniz. Lütfen bu tanıma uygun bir olayı mümkün olduğunca ayrıntılı biçimde, hayal ettiğiniz tüm detayları dahil ederek aşağıda verilen boşluğu kullanarak yazınız. Burada sizden beklenen bu olayın gerçekleşme ihtimali olan o dönemi ya da o anı değil, hayal ettiğiniz alternatif senaryoyu anlatmanızdır)*

APPENDIX B

PHENOMENOLOGICAL EXPERIENCE QUESTIONS

Autobiographical Event: How old were you when this event took place? Please indicate a single age. *(Bu olayı yaşadığınızda kaç yaşındaydınız? Lütfen bir yaş belirtiniz)*

Future Event: How old will you be when this event might take place in the future? Please indicate a single age. *(Bu olayı yaşadığınızda kaç yaşında olacaksınız?)*

Counterfactual Event: How old could you have been when this event might have taken place? Please indicate a single age. *(Bu olayı kaç yaşındayken yaşayabilirdiniz?)*

Now we are going to ask you some questions about the event you mentioned above. Please read each statement as you think about the event and rate the extent to which each statement describes your experience on the following 5-point scale. *(Şimdi yukarıda aktardığınız olay ile ilgili size kimi sorular soracağız. Lütfen her bir ifadeyi bu olayı düşünerek okuyun ve her bir ifadenin sizi ne ölçüde tanımladığını aşağıdaki 5 aralıklı ölçek üzerinde değerlendiriniz)*
1 = Strongly disagree (*Hiç katılmıyorum),* 5 = Strongly agree *(Tamamen katılıyorum)*

	1	2	3	4	5
I am reliving the original event. *(Bu olayı şu anda yaşıyor gibiyim)*					
I can see it in my mind. *(Bu olayı zihnimde görebiliyorum)*					
This event involves a lot of sensory information – sound, touch, smell, taste. *(Bu olay pek çok duyusal bilgi (ses, koku, tat vb.) içeriyor)*					
I know the spatial layout. *(Bu olayın geçtiği ortamın mekânsal düzenini biliyorum)*					
It comes to me as a coherent story. *(Bu olay bütünlüğü olan bir hikâye gibidir)*					
I can identify the actions, objects, setting, and/or people that are involved in the event. *(Bu olaya dahil olan eylemleri, nesneleri, ortamı ve/veya insanları tanımlayabilirim)*					

APPENDIX C

THE SCENE CONSTRUCTION TASK

Now we will give you descriptions of some environments and places. Please create a scene in your mind and describe it in detail for each setting. Here, what is expected of you is to free your imagination and try to visualize the whole scene in your mind while describing it. Remember to provide as much detail as possible and use all your available senses, including sight, hearing, and smell. Since we are interested in what you can visualize, you should imagine an entirely new scene instead of describing an event. *(Şimdi size bazı ortam ve mekanlar ile ilgili tanımlayıcı bilgiler vereceğiz. Sizden, her bir ortam/mekân için zihninizde bir sahne oluşturmanızı ve ayrıntılı biçimde betimlemenizi istiyoruz. Çalışmanın bu aşamasında sizden beklenen, hayal gücünüzü özgür bırakmanız ve anlatırken tüm sahneyi zihninizde canlandırmaya çalışmanızdır. Mümkün olduğu kadar çok ayrıntı vermeyi ve görme, işitme ve koku alma da dahil olmak üzere mevcut tüm duyularınızı kullanmayı unutmayın. Burada, zihninizde canlandırabildiklerinizle ilgilendiğimizden, bir olayı tarif etmek yerine, tamamen yeni bir sahne hayal etmeniz gerekmektedir)*

Beach *(Kumsal)*: Imagine you're lying on a deserted white sandy beach in a beautiful tropical bay. I want you to describe the experience and the surroundings in as much detail as possible using all your senses including what you can see, hear, and feel. *(Güzel ve ıssız bir tropik koydaki beyaz kumlu bir plajda uzandığınızı hayal edin. Görebildiğiniz, duyabildiğiniz ve hissedebildiğiniz de dahil olmak üzere tüm duyularınızı kullanarak deneyimi ve çevreyi mümkün olduğunca ayrıntılı bir şekilde tanımlayınız)*

Museum *(Müze)*: Imagine you're standing in the busy main hall of a museum containing many impressive exhibits. I want you to describe the experience and the surroundings in as much detail as possible using all your senses including what you can see, hear, and feel. *(Birçok etkileyici serginin yer aldığı bir müzenin yoğun ana salonunda durduğunuzu hayal edin)*

Street market *(Sokak Pazarı)*: Imagine you're standing in the middle of a bustling street market. I want you to describe the experience and the surroundings in as much detail as possible using all your senses including what you can see, hear, and feel. *(Kalabalık bir semt pazarının ortasında durduğunuzu hayal edin)*

Please think about the scene you have just imagined and answer the following questions by selecting the option that best reflects your experience. *(Lütfen az önce hayal ettiğiniz sahneyi düşünerek aşağıdaki soruları deneyiminizi en iyi yansıtan seçeneği işaretleyerek cevaplayınız)*

How much of a sense of being there did you have when imagining? *(Hayal ederken orada olma hissiniz ne kadar güçlüydü?)*
1 = Didn't feel like I was there at all (*Hiç oradaymışım gibi hissetmedim)*, 5 = Strongly felt like I was really there *(Güçlü bir şekilde oradaymışım gibi hissettim)*

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

How vivid was the scene you imagined in your mind's eye? *(Hayal ettiğiniz sahne ne kadar canlıydı?)* 1 = Not vivid at all *(Hiç canlı değildi)*, 5 = Extremely vivid *(Son derece canlıydı)*

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

Please consider the scene you have just imagined and select the descriptions that express your experience. *(Lütfen az önce hayal ettiğiniz sahneyi düşünerek, açıklamalardan deneyiminizi tarif eden seçenekleri işaretleyiniz)*

It was quite fragmented. *(Oldukça bölük pörçüktü)*	
I saw the scene in color. *(Sahneyi renkli gördüm)*	
It was similar to looking at a picture or seeing it on TV. *(Bir resme bakmaya ya da televizyon izlemeye benziyordu)*	
I could see individual details, but it didn't all fit together as a whole scene. *(Tek tek ayrıntıları görebiliyordum ama hepsi bir sahne olarak birbiriyle uyuşmuyordu)*	
I would find it easy to answer questions about the scene. *(Sahneyle ilgili sorulacak soruları kolaylıkla yanıtlayabilirdim)*	
It wasn't so much a scene as a collection of images. *(Tek bir sahneden çok parça parça görüntüler gibiydi)*	
I was able to use some senses other than vision, e.g., sound, smell. *(Görme dışındaki bazı duyuları da kullanabildim – örneğin ses, koku)*	
I could see it as one whole scene in my mind's eye *(Zihnimde bütün bir sahne olarak görebildim)*	
I was able to think of details associated with the general theme. *(Genel tema ile ilgili detayları düşünebildim)*	
I would find it easy to give further details of the surroundings in the scene. *(Olay yeri ve çevreyle ilgili kolaylıkla daha fazla ayrıntı verebilirdim)*	
It wasn't a scene you could step into; it wasn't really joined-up. *(Kolaylıkla dahil olabileceğim bütünlükte bir sahne değildi; kopuk kopuktu)*	
I would find it easy to substitute an aspect of the scene for something else. *(Sahnenin bir parçasının yerine kolaylıkla yeni bir parça koyabilirim)*	

APPENDIX D

PERSPECTIVE TAKING SUBSCALE OF

THE INTERPERSONAL REACTIVITY INDEX

The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate number on the scale. *(Aşağıdaki ifadeler, çeşitli durumlardaki düşünceleriniz ve duygularınız ile ilgilidir. Her bir ifade için, ölçekten uygun olan sayıyı seçerek, sizi ne kadar iyi tanımladığını belirtin)*
1 = Does not describe me well *(Beni iyi tanımlamıyor)*, 5 = Describes me very well *(Beni çok iyi tanımlıyor)*

	1	2	3	4	5
*I sometimes find it difficult to see things from the "other guy's" point of view. *(Bazen olayları diğer kişilerin bakış açısından görmekte zorlanırım)*					
I daydream and fantasize, with some regularity, about things that might happen to me. *(Başıma gelebilecek şeylerle ilgili düzenli olarak hayal kurarım)*					
*I try to look at everybody's side of a disagreement before I make a decision. *(Bir karar vermeden önce anlaşmazlığa herkesin bakış açısından bakmaya çalışırım)*					
Sometimes I don't feel very sorry for other people when they are having problems. *(Bazen başkalarının sorunları olduğunda onlar için çok üzülmem)*					
*I sometimes try to understand my friends better by imagining how things look from their perspective. *(Bazen işlerin arkadaşlarımın bakış açısından nasıl göründüğünü hayal ederek onları daha iyi anlamaya çalışırım)*					
In emergency situations, I feel apprehensive and ill-at-ease. *(Acil durumlarda, endişeli ve huzursuz hissederim)*					
*If I'm sure I'm right about something, I don't waste much time listening to other people's arguments. *(Bir konuda haklı olduğumdan eminsem, diğer insanların görüşlerini dinleyerek fazla zaman harcamam)*					

	1	2	3	4	5
* I believe that there are two sides to every question and try to look at them both. *(Her sorunun iki yüzü olduğuna inanırım ve ikisini de anlamaya çalışırım)*					
I often have tender, concerned feelings for people less fortunate than me. *(Benden daha az şanslı olan insanlara karşı genellikle şefkatli ve endişeli hissederim)*					
*When I'm upset at someone, I usually try to "put myself in his shoes" for a while. *(Birine sinirlendiğimde genellikle kendimi bir süre onun yerine koymaya çalışırım)*					
I am usually pretty effective in dealing with emergencies. *(Acil durumlarla baş etmede genellikle oldukça iyiyimdir)*					
*Before criticizing somebody, I try to imagine how I would feel if I were in their place. *(Birini eleştirmeden önce, onun yerinde olsaydım nasıl hissedeceğimi hayal etmeye çalışırım)*					

Note. * indicates items of the Perspective Taking Subscale of the Interpersonal Reactivity Index.

APPENDIX E

THE BRIEF VERSION OF THE AUTOBIOGRAPHICAL RECOLLECTION TEST

People vary a lot as to how they remember events from their life. The following questions are about how you remember your own memories for events you have experienced in the past. Please consider each item and indicate on a scale from 1 to 7 how much the description applies to the way you remember events from your past. Please consider how you remember past events and answer the questions in an honest and sincere way, by choosing a number between 1 (strongly disagree) and 7 (strongly agree). *(Yaşamdaki anıların nasıl hatırlandığı, bireyler arasında çok çeşitlilik gösterir. Aşağıdaki cümleler, geçmişte yaşadığımız olaylara dair hatırladıklarımız hakkındadır. Sizden ricamız her bir cümleyi okumanız ve geçmişinizdeki olayları hatırlama biçiminizi ne kadar yansıttığını puanlayarak belirtmeniz. Lütfen, geçmiş olayları nasıl hatırladığınızı düşünün ve cümleleri dürüst ve samimi bir şekilde değerlendirin. Cümleleri 1 = kesinlikle yanlış ve 7 = kesinlikle doğru olmak üzere 1 ile 7 arasında belirteceğiniz puanı seçerek değerlendirin)*

	1	2	3	4	5	6	7
My memories of past events have lots of details. *(Geçmiş olaylara dair anılarım çok detaylıdır)*							
My memories of past events come to me as good stories or descriptions. *(Geçmişe dair anılarım, bana iyi bir hikâye ve betimleme gibi gelir)*							
While remembering past events, it is as if I am reliving them. *(Geçmiş anılarımı hatırlarken, sanki onları tekrardan yaşıyormuş gibi olurum)*							
I often think back to past events in my mind and think or talk about them. *(Çoğu zaman zihnimde geçmiş olaylara döner ve onlar hakkında düşünür veya konuşurum)*							

	1	2	3	4	5	6	7
In my memories of past events, I remember where the actions, objects, and people are located in the events. *(Geçmiş olaylara dair anılarımda eylemlerin, nesnelerin ve insanların olayın içerisinde nerede konumlandığını hatırlarım)*							
While remembering past events, I can see them in my mind. *(Geçmiş olayları hatırlarken onları zihnimde görebilirim)*							
My memories of past events are a central part of my life story. *(Geçmiş olaylara dair anılarım, hayat hikayemin merkezi bir parçasıdır)*							

APPENDIX F

APPEARANCE SUBSCALE OF

THE PLYMOUTH SENSORY IMAGERY QUESTIONNAIRE

The purpose of this test is to measure the vividness of visual imagery. Please try to form a clear image for each statement, and rate how vivid each image you have formed on the rating scale shown below. *(Bu testin amacı, görsel imgelemin canlılığını ölçmektir. Her bir ifadeyle ile ilgili belirli bir imge oluşturmaya çalışın ve oluşturduğunuz her bir imgenin ne kadar canlı olduğunu aşağıda gösterilen derecelendirme ölçeğine göre değerlendiriniz.)*
0 = No image at all *(Hiç görüntü yok)*, 10 = As vivid as real life *(Gerçek hayat kadar canlı)*

	0	1	2	3	4	5	6	7	8	9	10	11
Bonfire *(Kamp ateşi)*												
Sunset *(Gün batımı)*												
A cat climbing tree *(Ağaca tırmanan bir kedi)*												

APPENDIX G

ETHICS COMMITTEE APPROVAL FORM

Evrak Tarih ve Sayısı: 03.03.2022-56365

T.C.
BOĞAZİÇİ ÜNİVERSİTESİ
SOSYAL VE BEŞERİ BİLİMLER YÜKSEK LİSANS VE DOKTORA TEZLERİ ETİK İNCELEME KOMİSYONU
TOPLANTI KARAR TUTANAĞI

Toplantı Sayısı	:	28
Toplantı Tarihi	:	03.03.2022
Toplantı Saati	:	11:30
Toplantı Yeri	:	Zoom Sanal Toplantı
Bulunanlar	:	Prof. Dr. Ebru Kaya, Prof. Dr. Nevra Seggie, Dr. Öğr. Üyesi Yasemin Sohtorik İlkmen
Bulunmayanlar	:	

Çağla Duman
Psikoloji

Sayın Araştırmacı,
"Cognitive Processes Underlying Episodic Mental Time Travel/ Epizodik Zihinsel Zaman Yolculuğunun Altında Yatan Bilişsel Süreçler" başlıklı projeniz ile ilgili olarak yaptığınız SBB-EAK 2022/11 sayılı başvuru komisyonumuz tarafından 3 Mart 2022 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Bu karar tüm üyelerin toplantıya çevrimiçi olarak katılımı ve oybirliği ile alınmıştır. COVID-19 önlemleri kapsamında kurul üyelerinden ıslak imza alınamadığı için bu onay mektubu üye ve raportör olarak Yasemin Sohtorik İlkmen tarafından bütün üyeler adına e-imzalanmıştır.

Saygılarımızla, bilgilerinizi rica ederiz.

Dr. Öğr. Üyesi Yasemin
SOHTORİK İLKMEN
Öğretim Üyesi

e-imzalıdır
Dr. Öğr. ÜyesiYasemin Sohtorik
İlkmen
Öğretim Üyesi
Raportör

SOBETİK 28 03.03.2022

Bu belge, güvenli elektronik imza ile imzalanmıştır.

APPENDIX H

DEMOGRAPHIC INFORMATION FORM

Gender *(Cinsiyetiniz)*:

_____

Date of Birth – day/month/year *(Doğum tarihiniz – gün/ay/yıl)*:

_____

Considering the living conditions in Turkey, at which socioeconomic level would you position yourself? *(Türkiye'deki yaşam şartlarını göz önünde bulunduracak olursanız kendinizi hangi sosyoekonomik seviyede konumlandırırsınız?)*

- ○ Low *(Düşük)*
- ○ Low-middle *(Düşük-orta)*
- ○ Middle (*Orta)*
- ○ Middle-high *(Orta-yüksek)*
- ○ High *(Yüksek)*

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