Autobiographical memories, or events from our personal past, are composed of detailed sensorial and perceptual information, which distinguishes these events from imagination (Johnson et al., 1988). Sensory information, such as taste and smell, can be powerful cues to elicit autobiographical memories (e.g., Ernst et al., 2021; for review see Hacklander et al., 2019). However, a number of lines of evidence indicate that vision is the more critical sense when it comes to remembering autobiographical memories (Brewer, 1996). Visual imagery, the ability to evoke images of objects and scenes in the mind’s eye and typically measured by subjective reports of vividness, is one of the best predictors of the sense of recollection or the subjective sense of reexperiencing (Rubin et al., 2003; Rubin & Siegler, 2004) and individuals with greater visual imagery ability recall more detailed autobiographical memories and imagined future events (e.g., D’Argembeau & Van der Linden, 2006). According to the basic-systems model of memory (Rubin, 2005) visual aspects of memory are critical for autobiographical memory. Supporting this idea, patients with damage to posterior neocortical areas, such as the precuneus and visual cortex associated with visual imagery and long-term storage of visual memory, are severely impaired on autobiographical memory retrieval for events that occurred prior to their injury (i.e., retrograde memory) despite preservation of the medial temporal lobe (Ahmed et al., 2018; Gardini et al., 2011; Ogden, 1993; Rubin & Greenberg, 1998).

An integral, but frequently overlooked, aspect of visual imagery is that it requires a particular vantage point or window from which to view visual informa-
tion in the mind’s eye. That is, during autobiographical memory retrieval, there is always a rememberer who is immersed in the event being remembered. Tulving (1983) referred to this as autoenic consciousness, or the knowledge that it is the self that mentally time travels when retrieving episodic memories. Although memories are typically formed through one’s own eyes, as rememberers we can flexibly shift to alternative locations in our mental model of memory in which we effectively see ourselves in the event, such when the character in Diana Gabaldon’s historical work of fiction, *Dragonfly in Amber*, remembers his memory of the Battle of Culloden as if he were watching himself in the event. The idea that we have multiple viewpoints in memory was noted in early reports examining childhood memories (e.g., Henri & Henri, 1898), and the presence of alternative perspectives in memories was proposed to reflect the reconstruction or even the distortion of childhood memories (for review see Rice, 2010). The first empirical study of visual perspective in memory was conducted by Nigro and Neisser (1983). In this seminal study, they confirmed the existence of multiple visual perspectives in memories and demonstrated that memories associated with an own eyes perspective were also more recent, supporting the idea that the presence of observer perspectives might reflect mnemonic changes that occur in memories over time. These initial findings have been well replicated in the literature in both memories (e.g., Rice & Rubin, 2009) and imagined events (e.g., D’Argembeau & Van der Linden, 2004), and other studies have further shown that visual perspective impacts the phenomenology and content of these event memories (for review see Rice, 2010). However, rather than being merely an epiphenomenon of the transformation of memories over time, recent research has revealed that visual perspective can also reshape memories online and over the longer term and has also begun to investigate the neural mechanisms supporting this integral aspect of visual imagery in autobiographical memory (for review see St. Jacques, 2019). These findings are consistent with memory theory indicating that retrieval is an active process that can update memories with new information, which may sometimes contribute to distortions or other changes in memories (for review see Schacter et al., 2011).

In this chapter, I review behavioral and neuroimaging research on visual perspective in memories for events, including autobiographical memories and episodic simulation. I will describe how visual perspective influences the vividness of events, emerging research on how events are formed from multiple visual perspectives, and the neural mechanisms that support visual perspective. Before reviewing this research, I first discuss the nature of visual perspective in memories for events.

**Nature of visual perspective**

The term visual perspective has been described in many ways and is also used in a number of different domains. For example, perspective can refer to the ability to understand another person’s point-of-view, such as in theory of mind, when one takes an altercentric (i.e., another person’s) rather than an egocentric (i.e., self) perspective. It can also refer to the ability to consider and use first-person or third-person perspectives in narrative (e.g., Pennebaker et al., 2003) or first-person
and third-person avatars in virtual reality (e.g., Vogeley et al., 2004). Although there may be some similarities between the concept of visual perspective among these different domains (e.g., Buckner & Carroll, 2007), in this chapter the term visual perspective specifically refers to where one places the self-perspective, rather than the ability to adopt another person's viewpoint. Nigro and Neisser (1983), originally referred to two types of visual perspective: (1) field memory, indicating the original field of view from which events were encoded, and (2) observer memory, reflecting seeing oneself from the outside. I prefer the term own eyes perspective rather than field memory, since it does not require reference to the original perspective during encoding, and the term observer-like perspective to better capture the idea of seeing oneself from a self-perspective rather than adopting another person's viewpoint.

Having a viewpoint is an inherent aspect of many models of event memory (Byrne et al., 2007; Cooper et al., 2019; Rubin & Umanath, 2015), in which mental representations of events are thought to involve an egocentric spatial framework that is centered with respect to the location of the self. In their theory of event memory, Rubin and Umanath (2015) make this explicit when they indicate that mental scenes must have a visual perspective—irrespective of whether it is own eyes or observer-like. Other researchers have linked own eyes perspectives specifically to an egocentric spatial framework and have described observer-like perspectives as involving an allocentric spatial framework in which the world space is independent from the self (e.g., Freton et al., 2014; Hebscher et al., 2018). However, it's very rare for observer-like perspectives in memories to have the type of map-like representation implied by an allocentric framework (e.g., Rice & Rubin, 2011). Instead, observer-like perspectives are better described as involving a translocation of the self within the mental model of the event rather than a transformation from an egocentric to an allocentric spatial framework. Supporting this idea, the tendency to adopt an observer perspective in memory is linked to the involvement in brain regions associated with egocentric abilities (e.g., posterior parietal cortices; as reviewed below).

Visual perspective is a flexible and dynamic characteristic of event memory, which can change depending upon the type of event and the particular perspective adopted. For example, Nigro and Neisser (1983) showed that a higher frequency of observer-like perspectives is reported for events that involve a greater sense of self-awareness and emotion during encoding (e.g., giving a presentation, being in a group performance), whereas own eyes perspectives are more frequent for events that are low on these aspects (e.g., watching the news, running for exercise). Other researchers using the same types of events have found similar effects for both memories and imagination (McDermott et al., 2016; Rice & Rubin, 2011). When an observer-like perspective is adopted it can be placed in several possible locations within the mental representation of the event. Rice and Rubin (2011) showed this clearly when they asked people to categorize the height, distance, and location of visual perspective in autobiographical memories. They found that observer-like perspectives tend to occur more frequently near or above at eye-level but equally located at front/back, left/right, and shorter/longer distances with respect to the
location the rememberer originally perceived the event. Similar patterns in the location of observer-like perspectives have also been demonstrated in future events except that they are more frequently experienced below eye-level than past events (McDermott et al., 2016; see Figure 16.1A). The location of observer-like perspectives reported in event memories also distinguishes them from the phenomenon of out-of-body experiences in which people frequently report floating above their body and other vestibular and gravitational changes in the location of the self (Blanke, 2012). Although events can be experienced and remembered from multiple visual perspectives, the own eyes perspective tends to be dominant in most individuals (Radvansky & Svob, 2019).

The dynamic nature of visual perspective means that multiple visual perspectives can occur within a single event. For example, Rice and Rubin (2009) found that participants frequently reported more than one visual perspective can be experienced when remembering an autobiographical memory when they were able to subjectively rate the degree of own eyes and observer-like perspectives on separate scales, with a significant proportion of memories associated with high or low ratings on both perspective scales (see Figure 16.1B). On the basis of these findings, Rice and Rubin (2009) proposed an independent framework for visual perspective in which events can contain a mixture of own eyes and observer-like perspectives. Supporting this idea, other research has demonstrated that manipulations that increase one perspective do not lead necessarily to a decrease in the other perspective (e.g., Marcotti & St Jacques, 2018; Marcotti & St. Jacques, 2021), and that mental imagery of events can alternate between own eyes and observer-like perspectives (Day et al., 2004). Thus, including separate scales to measure own eyes and observer-like perspectives, or including an option that combines both within a single event, is considered the gold standard to best capture the dynamic

Figure 16.1  (A) The percentage of observer-like perspectives in autobiographical memories according to their egocentric location within the mental representation. Adapted from Rice and Rubin (2011), with permission from Elsevier. (B) Own eyes and observer perspective ratings showing the total number of memories given a particular combination on each rating scale, supporting an independent framework. Adapted from Rice and Rubin (2009), with permission from Elsevier. (C) There are significant reductions in subjective ratings of vividness when shifting from an own eyes to an observer perspective (Shift) compared to maintaining an own eyes perspective (Maintain). Data based on Marcotti and St. Jacques (2018).
aspect of visual perspective in event memory, in which a single event can oscillate between both types of viewpoint. Moreover, recent research has suggested that the degree to which the self is visible when adopting an observer-like perspective is also important to capture the multidimensional nature of visual perspective (Kinley et al., 2021).

**Visual perspective influences remembering and imagination**

Visual perspective influences both the phenomenology and the objective content of memories and imagined events (for reviews see Rice, 2010; St. Jacques, 2019). In general, own eyes perspectives are associated with memory characteristics that enable a sense of reexperience when compared to adopting an observer perspective, such as the emotional intensity experienced during remembering and imagination (e.g., Grol et al., 2017; Sekiguchi & Nonaka, 2014; St Jacques et al., 2017; Vella & Moulds, 2014; for review see Rice, 2010). Here I focus in particular on research demonstrating how visual perspective influences the vividness of visual imagery and the types of details recalled in memories and imagined events.

A number of studies have found that observer perspectives are associated with reduced vividness in memories (Akhtar et al., 2017; Butler et al., 2016; Grisham et al., 2019; Marcotti & St Jacques, 2018; Marcotti & St. Jacques, 2021; Sutin & Robins, 2010; Talarico & Rubin, 2003; Williams & Moulds, 2008) and episodic simulation (D’Argembeau & Van der Linden, 2012; Hamilton & Cole, 2017; McDermott et al., 2016; Verhaeghen et al., 2018; White et al., 2019; Wong et al., 2020). One reason is that observer-like perspectives are associated with more remote events that are also less vivid. For example, Verghaegen et al. (2018) examined the role of visual perspective in memory and future events in which participants provided a subjective rating of the amount of visual detail. They found that the reported visual perspective of these events was predicted by ratings of visual detail, with higher ratings contributing to own eyes perspectives and lower ratings to observer-like perspectives. However, the temporal distance of the event also predicted visual perspective ratings, with more recent memories associated with own eyes ratings and more remote memories with observer ratings. Moreover, temporal distance is a significant predictor of visual perspective even after controlling for changes in the vividness of events (D’Argembeau & Van der Linden, 2012). These findings are consistent with research demonstrating an increase in observer ratings in autobiographical memories coupled with reductions in memory vividness that both occur over time (Talarico & Rubin, 2003). Other research has shown that rehearsing newly formed own eyes memories can protect them from resulting reductions in vividness and the natural shift from own eyes to observer-like perspectives that occurs over time (Butler et al., 2016). Critically, however, changes in subjective aspects of visual imagery also occur as the result of manipulating visual perspective during remembering and imagination (Akhtar et al., 2017; Berntsen & Rubin, 2006; Butler et al., 2016; Marcotti & St Jacques, 2018; Vella & Moulds, 2014). For example, Marcotti and St. Jacques (2018) asked people to shift from an own eyes to an observer-like perspective and reported a reduction in vividness ratings when
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compared to maintaining an own eyes perspective (see Figure 16.1C). Similarly, Vella and Moulds (2014) found that shifting to an observer-like perspective was associated with a reduction in vividness during autobiographical memory retrieval as well as imagined future events. Thus, differences in visual perspective can occur as the result of the vividness of event memories but manipulating visual perspective during remembering and imagination also leads to changes in vividness.

Reductions in the vividness of event memories when shifting to an observer-like perspective might reflect the loss of visual information, as reflected by the asymmetrical pattern of findings reported when shifting back to an own eyes perspective (Butler et al., 2016; Williams & Moulds, 2008). For example, Butler et al. (2016) asked participants to adopt an observer-like perspective for autobiographical memories and laboratory-based events that were formed from an own eyes perspective. They found that repeatedly adopting an observer-like perspective across a period of a month led to a reduction in vividness ratings coupled with higher observer ratings. When they asked participants to shift back to an own eyes perspective for these same memories on a final retrieval attempt, they found that participants were not able to regain the same level of vividness that was lost due to repeatedly shifting to an observer perspective. Supporting the idea that reductions in vividness contribute to forgetting, Ahktar et al. (2017) found that reductions in vividness ratings when shifting from an own eyes to an observer-like perspective were coupled with reductions in the amount of perceptual details in narratives along with other episodic details (e.g., actions, places, and people). Similarly, the aforementioned study by Marcotti and St. Jacques (2018) found that the differences in vividness ratings when shifting from an own eyes to an observer-like perspective during retrieval uniquely predicted differences in subsequent accuracy of memories for visual and other types of information above and beyond differences in task difficulty related to perspective shifting. Recent studies have suggested that subjective ratings of vividness are driven by the precision or fidelity of visual information during memory retrieval rather than the overall quantity of information (e.g., Cooper et al., 2019; Richter et al., 2016). An intriguing avenue for future research will be to understand why adopting an observer-like perspective reduces subjective ratings of vividness, and whether this is due to differences in the precision or the quantity of visual and other information during remembering as memories are visualized from a novel location.

Adopting a novel self-location also influences the other types of information recalled during memory and imagination. According to one theory, adopting an observer-like perspective during mental imagery might lead to a greater focus on abstract rather than concrete aspects of events (Libby & Eibach, 2011). Observer-like perspectives are associated with a decrease in the number of emotions, thoughts, and physical sensations reported during recall when compared to own eyes perspectives (e.g., Bagri & Jones, 2009; Eich et al., 2009; McIsaac & Eich, 2002, 2004). Some studies have found that adopting an observer-like perspective increases recall related to spatial information (Marcotti & St. Jacques, 2021; McIsaac & Eich, 2002, 2004). For example, McIsaac and Eich (2002) asked participants to encode mini-events formed in the laboratory from their own eyes
(e.g., working with clay), and then to recall the events from either an own eyes or observer-like perspective. They found that participants recalled more spatial information about the location of objects. These findings were replicated in a subsequent study using the same paradigm examining trauma memories (McIsaac & Eich, 2004). However, other studies have failed to replicate the boost in spatial information when adopting an observer-like perspective (Bagri & Jones, 2009; Eich et al., 2009; Marcotti & St Jacques, 2018). For example, Marcotti and St. Jacques (2021) found that participants who adopted an observer-like perspective compared to an own eyes perspective during recall of mini-events encoded in the laboratory had more errors on a subsequent test of spatial memory. Understanding the influence of visual perspective on spatial information may require better distinguishing whether spatial information depends upon whether objects are tested based on egocentric (i.e., in relation to the self) or allocentric (i.e., in relation to other objects) reference frames.

**Forming memories from multiple visual perspectives**

The majority of studies have examined how visual perspective influences memory retrieval and episodic simulation of imagined events, but visual perspective also contributes to the formation of event memories (McCarroll, 2017, 2018; Nigro & Neisser, 1983). Although we typically experience events through our own eyes (Radvansky & Svob, 2019), observer-like imagery is frequent during imagination (Christian et al., 2013) and could contribute to the formation of memories in the absence of direct sensory information from this same viewpoint (McCarroll, 2017, 2018). A number of studies have shown that some individuals have an increased propensity to consider and use observer-like perspectives in daily life (e.g., Brewin, Gregory, Lipton, & Burgess, 2010; Clark & Wells, 1995; Cohen & Gunz, 2002; Riva & Gaudio, 2012), which might contribute to an increased frequency in adopting an observer-perspective in memories for these experiences. Other studies have also manipulated the use of observer-like imagery during encoding of real-world events (Spurr & Stopa, 2003), with one study finding that memory for these recent events was later retrieved from the same viewpoint as encoding (Mooren et al., 2016). The availability of visual information during memory encoding can also influence visual perspective in these events. For example, preventing the encoding of visual information in video events by blindfolding participants results in higher observer perspectives in memories for these same events (Rubin et al., 2003), presumably because there is less perceptual information to instantiate the vivid recall of memories associated with an own eyes perspective. These findings parallel research in episodic simulation in which an increased frequency in adopting an observer-like perspective in future events is associated with reduced vividness (e.g., Vella & Moulds, 2014). Other theories have proposed that observer-like perspectives contribute to the formation of events that are highly negatively emotional or stressful and highly self-evaluative (McCarroll, 2017, 2018), which might explain the increased frequency of observer-like perspectives when participants are asked to recall traumatic memories (e.g., McIsaac & Eich, 2004). One limitation of this
research, however, is that it is challenging to determine whether changes in viewpoint contributed to memory encoding or emerged during later retrieval of such events (also see Rubin et al., 2008).

Recent research using virtual and augmented reality has demonstrated that it is possible to effectively manipulate visual perspective during immersive events experienced in both real-world and virtual environments and offers a promising way to investigate the role of visual perspective during memory encoding. One line of research has manipulated visual perspective during the encoding of events in immersive virtual reality. For example, Iriye and St. Jacques (2021) manipulated whether participants encoded an immersive virtual environment (e.g., a café) from a first-person or third-person avatar perspective (see Figure 16.2). Critically, in one study they also used bespoke avatars that physically resembled each participant coupled with a training task in which participants viewed “themselves” (i.e., their virtual avatar) in a mirror in the virtual environment from first-person and third-person perspectives, thus, mimicking the experience of self-perspective in autobiographical memories. They found that events formed from a third-person avatar perspective were later remembered more from an observer-like perspective when compared to events formed from a first-person avatar perspective, suggesting that the viewpoint experienced during encoding was effective in forming memories from multiple visual perspectives. However, there was no difference in the recall of visual information, nor differences in vividness of memories even after a delay of one week. These initial findings suggest that the impact of visual perspective during memory encoding might be much different than the reported effects of visual perspective during memory retrieval (also see Mooren et al., 2016). Interestingly, memories encoded from a third-person avatar perspective were associated with
broadened perspective for the overall spatial layout of the event (Study One), but not when the difference in the camera field of view between the two perspectives was equated (Study Two). Given that adopting an observer-like perspective typically requires physically distancing oneself from the central aspects of the event it may naturally involve a greater focus on surrounding details in the scene (e.g., Abelson, 1975).

Other research has used a standard out-of-body illusion to manipulate visual perspective during memory encoding (Ehrsson, 2007; Lenggenhager et al., 2007). In the out-of-body illusion manipulation participants wear an immersive virtual reality headset that is fed from a 360-degree video camera located either at the same location as their own eyes or from an observer-like perspective in which they see themselves in real-time in the lab while experiencing multisensory synchronous feedback (i.e., physical stroking of the body in parallel with visual feedback at the site of the illusory body). Thus, these studies manipulate visual perspective and the sense of embodiment. In one study, Bergouignan, Nyberg, and Ehrsson (2014) manipulated whether participants experienced a social interaction with an actor from an embodied own eyes or observer-like perspective. When memories were tested one week later, they found a reduction in the subjective sense of recollection, which was linked to a decrease in the emotional, spatial, and temporal information in events. In a second study, they also showed a reduction in subjective ratings of vividness when initially retrieving memories encoded from an out-of-body perspective. This novel study suggests that out-of-body experiences during memory encoding can contribute to later changes in the subjective experience of these events. However, it is unclear whether the reported changes in memory were due to differences in visual perspective, embodiment, or their combination.

For example, other research has shown that the bodily aspect of the own eyes perspective contributes to the successful formation of memories for personally experienced events (Brechet et al., 2020; Brechet et al., 2019). Thus, an important avenue for future research will be to disentangle the effects of visual perspective and embodiment during memory encoding.

**Neural mechanisms of visual perspective in memory**

There is growing evidence that regions within the posterior parietal cortex play an important role in visual perspective in event memory (St. Jacques, 2019). The posterior parietal cortex is linked to egocentric representations during spatial memory and mental imagery (Byrne et al., 2007), such that damage to this region impairs egocentric-based spatial tasks while leaving allocentric types of spatial tasks intact (Aguirre et al., 1998; Bisiach & Luzzatti, 1978; Ciaramelli et al., 2010; Wilson et al., 2005). Moreover, Russell and colleagues (2019) found that patients with parietal damage were selectively impaired on visual perspective in episodic memories. They created a novel task in which participants were asked to encode the location of objects on a $2 \times 2$ grid placed in front of them that was orientated from a particular viewpoint. During a forced-choice recognition memory test, participants were then asked to choose the correct image depicting the identical grid objects...
and viewpoint as encoding. Parietal patients had intact item-based memory for the grid objects but were impaired on distinguishing the correct viewpoint they had experienced during encoding, when compared to healthy controls. Recent evidence from neuroimaging studies in healthy individuals has indicated that two regions within the posterior parietal cortex, the precuneus and angular gyrus, support visual perspective in event memory, as reviewed below.

The precuneus, located along the medial surface of the posterior parietal cortex, has long been associated with both egocentric mental imagery abilities and episodic memory retrieval (Cavanna & Trimble, 2006). Structural neuroimaging studies have shown that individual differences in the volume of gray matter in the precuneus are associated with a greater propensity to naturally adopt an own eyes perspective during autobiographical memory (Freton et al., 2014; Hubscher et al., 2018). Functional neuroimaging studies have found greater neural recruitment of the precuneus when adopting an observer than an own eyes perspective (Faul et al., 2020; Grol et al., 2017; Iriye & St Jacques, 2020; St Jacques, Carpenter et al., 2018; St. Jacques et al., 2017), which has been attributed to greater demands to adopt a novel viewpoint during retrieval (St Jacques et al., 2017). For example, St. Jacques et al. (2017) investigated the role of shifting visual perspective during autobiographical memory retrieval. They controlled for the natural perspective of memories based on subjective ratings of own eyes and observer memories in a pre-scanning session. Then during fMRI scanning one week later, participants were asked to adopt a novel observer perspective or to maintain the original own eyes perspective of memories. They found greater recruitment of the precuneus when adopting a novel observer perspective compared to maintaining an own eyes perspective (see Figure 16.3A). Additionally, precuneus recruitment also predicted subsequent changes in the visual perspective of memories in which participants reported lower own eyes ratings coupled with higher observer ratings, providing evidence that the precuneus also contributes to behavioral changes in the viewpoint of memories. In a second study, St. Jacques et al. (2018) demonstrated that the precuneus is recruited irrespective of the direction of the shift in visual perspective (i.e., either to a novel observer or own eyes perspective) when compared to maintaining the same visual perspective during autobiographical memory retrieval (see Figure 16.3B). Interestingly, Hubscher, Ibrahim, and Gilboa (2020) used continuous theta burst stimulation to suppress left precuneus activity during retrieval of recent autobiographical memories from the last year but found no significant effects on visual perspective ratings. One interpretation of these findings is that that virtual lesions to this precuneus have little impact when there are no demands to shift viewpoint (i.e., dominant own eyes perspective in recent memories). Other evidence from spatial navigation has also linked the precuneus with the ability to spatially update one’s location (e.g., Wolbers et al., 2008), suggesting that this region involves the flexible ability to map internal representations of space with novel egocentric coordinates. Thus, rather than supporting the ability to adopt a particular visual perspective per se, engagement of the precuneus during remembering and imagination might instead reflect the construction of mental representations from a novel viewpoint.
Figure 16.3 Neural mechanisms supporting visual perspective during event memory. (A) Shifting visual perspective during autobiographical memory retrieval recruits the angular gyrus and precuneus. Adapted from St. Jacques et al. (2017). (B) The precuneus is recruited irrespective of the direction of the shift in perspective. Gray bars represent the percent signal change when shifting perspective (Shifted) or maintaining the same perspective (NonShifted) across memory repetitions. Memories with a dominant own eyes (blue bars) or observer (orange bars) are also shown. Based on data from St. Jacques et al. (2018). (C) Adopting a novel perspective recruits the precuneus, whereas adopting a novel counterfactual (Cfact) recruits the dorsal medial prefrontal cortex (PFC). Adapted from Faul et al. (2020). (D) Common recruitment of the angular gyrus when adopting a novel perspective (O = observer perspective) or a novel counterfactual (W = worse counterfactual, B = better counterfactual), when compared to autobiographical remembering (R = remembering autobiographical memories). Adapted from Faul et al. (2020). (E) Greater interactions within a posterior medial network occur early during retrieval of autobiographical memories when adopting a typical own eyes (OE) compared to an atypical observer (OB) perspective. Based on a functional connectivity analysis with the anterior hippocampus. Reprinted from Iriye and St. Jacques (2020).
A couple of studies have found that neural recruitment of the precuneus is unique to constructive aspects of remembering that occur when shifting visual perspective (Faul et al., 2020; also see St Jacques et al., 2018). For example, Faul and colleagues (2020) examined neural mechanisms associated with adopting an alternative visual perspective compared to adopting an alternative outcome of the personal past or an episodic counterfactual simulation. They found greater precuneus recruitment when shifting to a novel observer perspective during remembering compared to episodic counterfactual simulation, whereas simulation led to greater recruitment of the dorsomedial prefrontal cortex (see Figure 16.3C). These findings are consistent with a recent model of constructive memory (Sheldon et al., 2019), which attributes posterior brain regions (including precuneus) with the reconstruction of autobiographical memories based on perceptual representations. Supporting these ideas, damage to the precuneus reduces visual imagery abilities in memory (Ahmed et al., 2018; Gardini et al., 2011), and functional neuroimaging studies have linked the precuneus to the vividness of visual imagery during memory retrieval (e.g., Fuentemilla et al., 2014; Richter et al., 2016). Although a number of studies have highlighted the role of the precuneus during later stages of autobiographical retrieval when perceptual and sensorial details of memories are elaborated upon (Daselaar et al., 2008; Hebscher et al., 2020; Iriye & St Jacques, 2020; McCormick et al., 2015), precuneus recruitment related to visual perspective has been shown to impact both early and late stages of retrieval (Hebscher et al., 2020; Iriye & St Jacques, 2020). For example, Hebscher et al. (2020) found that left precuneus stimulation affected both early and late stages of autobiographical retrieval, but only later stages of memory elaboration were linked to lower own eyes ratings as the result of virtual lesions. However, other research has shown greater involvement of the precuneus very early during autobiographical memory when participants were instructed to adopt an atypical observer-like perspective when compared to an own eyes perspective (Iriye & St Jacques, 2020). The precuneus may thus dynamically contribute to the ability to represent and adopt a novel viewpoint by reconstructing perceptual information in mental representations of events, which would also be consistent with reported behavioral changes in vividness of memories when shifting visual perspective (as reviewed above).

Evidence also indicates a role for the angular gyrus in visual perspective in event memory, a region located on the lateral surface of the posterior parietal cortex and frequently recruited during episodic memory retrieval and episodic simulation (Benoit & Schacter, 2015; Kim, 2010; Spaniol et al., 2009). For example, Bonnici, Cheke, Green, FitzGerald, and Simons (2018) examined the causal role of the left angular gyrus during autobiographical recall and found that virtual lesions here led to a significant reduction in the number of memories associated with an own eyes perspective. Other research has found that the angular gyrus is recruited more when adopting a novel observer perspective (Faul et al., 2020; Iriye & St Jacques, 2020; St Jacques et al., 2017), perhaps reflecting greater demands to adopt a novel viewpoint rather than being uniquely involved in either own eyes or observer-like perspectives. Unlike the precuneus, however, the angular gyrus is commonly recruited when adopting a novel viewpoint during remembering or changing the
outcome of a past event (Faul et al., 2020; St Jacques et al., 2018; see Figure 16.3D), suggesting that it plays a broader role in reconstructing memories in novel ways rather than the specific perceptual changes in memories that occur when shifting visual perspective that are associated with the precuneus. There is strong evidence that the angular gyrus is also causally involved in representing bodily aspects of self-location associated with visual perspective. For example, damage to the right angular gyrus and surrounding temporal parietal junction contributes to out-of-body experiences (e.g., Blanke, 2004; Ionta et al., 2011), and virtual lesions here lead to difficulties in distinguishing between in-body and out-of-body perspectives (de Boer et al., 2020). Moreover, intracranial stimulation of the right angular gyrus has been shown to produce out-of-body experiences (Blanke et al., 2002; De Ridder et al., 2007). Although there is much debate regarding the function of the angular gyrus given its involvement across several domains, a number of theories have proposed that the angular gyrus contributes to event representations by dynamically integrating multimodal contextual features of events across time and space (Humphreys et al., 2021; Ramanan et al., 2018; Seghier, 2013), as well as the sense of being self-located within those experiences (Brechet et al., 2018). Thus, the angular gyrus may support the reconstruction of the multiple features that comprise event representations when adopting a novel self-location within this experience.

Interactions between the precuneus and angular gyrus and within a broader posterior medial network (Byrne et al., 2007; Ritchey & Cooper, 2020) also contribute to visual perspective in event memory. Two early fMRI studies suggested greater involvement of the hippocampus in adopting an own eyes perspective during autobiographical memory retrieval (Piolino et al., 2009; St Jacques et al., 2013). For example, St. Jacques et al. (2013) found that during autobiographical memory retrieval participants who had stronger recruitment within a medial temporal lobe network, including the hippocampus, also reported higher own eyes ratings on average when later rating these same memories. In another study, Bergouignan et al. (2014) found that memories encoded from an observer-like perspective were associated with less recruitment in the hippocampus when memories were initially retrieved. Other research has demonstrated that increased hippocampal connectivity with posterior parietal regions during autobiographical memory retrieval contributes to the ability to adopt novel observer perspectives (Faul et al., 2020; Iriye & St Jacques, 2020). For example, Iriye and St. Jacques (2020) asked participants to recall autobiographical memories cued by familiar spatial locations while adopting an own eyes perspective compared to typical (within 6 feet at eye level) and more atypical (within 6 feet at floor level) observer perspectives. They found greater anterior hippocampal connectivity with regions in the posterior medial network, including the precuneus and angular gyrus, when participants were instructed to adopt a more atypical observer perspective compared to an own eyes perspective (see Figure 16.3E). Interactions between the hippocampus and the posterior parietal network are thought to reflect the transformation of stored allocentric representations of long-term memory in the hippocampus to egocentric representations experienced during event representation in the precuneus (Byrne et al., 2007; Ritchey & Cooper, 2020). Thus, adopt-
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ing a novel perspective, such as when taking a more atypical observer viewpoint, may place greater demands on this transformation circuit. Interestingly, Iriye and St. Jacques (2020) found that as retrieval progressed to later stages of elaboration there was a reversal in the pattern of connectivity between the hippocampus and precuneus from observer to own eyes perspective. Thus, the evidence reviewed here highlights that visual perspective in event memory is supported by dynamic changes in the involvement of the precuneus and its putative interactions with the hippocampus across the time-course of autobiographical memory retrieval.

Conclusion

Visual perspective is an integral aspect of immersive memories and imagined events. The evidence reviewed here indicates that visual perspective is a dynamic and flexible aspect of event memories, which influences vividness during remembering and imagining, and is associated with neural recruitment in posterior parietal cortices and a wider posterior medial network centered on the hippocampus. Moreover, the similarities between visual perspective in memory and imagination demonstrate how vantage point contributes to both the reconstruction and construction of mental representations of events, with recent evidence using immersive virtual reality methodologies suggesting a fundamental role for visual perspective during the formation of memories. Despite nearly 40 years of empirical investigation on this topic, however, many questions remain about the nature of visual perspective in memory and imagination. The current review offers several directions for future research in this area including examining why visual perspective reduces vividness, the influence of visual perspective on spatial information, delineating the contribution of viewpoint and embodiment on memory, and the unique role played by the precuneus and angular gyrus in visual perspective.

References


Verhaeghen, P., Aikman, S. N., Doyle-Portillo, S., Bell, C. R., & Simmons, N. (2018). When I saw me standing there: First-person and third-person memories and future projections,


