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Simulating the best and worst of times: The powers and perils of emotional simulation

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Abstract

We are remarkably capable of simulating events that we have never experienced. These simulated events often paint an emotional picture to behold, such as the best and worst possible outcomes that we might face. This review synthesizes dispersed literature exploring the role of emotion in simulation. Drawing from work that suggests that simulations can influence our preferences, decision making, and prosociality, we argue for a critical role of emotion in informing the consequences of simulation. We further unpack burgeoning evidence suggesting that the effects of emotional simulation transcend the laboratory. We propose avenues by which emotional simulation may be harnessed for both personal and collective good in applied contexts. We conclude by offering important future directions.

Keywords: *Decision making, emotion, episodic future simulation, prospection*

Introduction

Time passes, moving us along a continuous path of life experiences. Humans have the phenomenal ability to momentarily step away from this path by constructing mental representations of events outside of the here and now. That is, despite being rooted to the present moment, we can simulate events in our minds that take us *back* in time to relive the past (i.e., memory) or project us *forward* in time to pre-experience possible futures (Gilbert & Wilson, 2007; Schacter et al., 2008, 2017). Work in cognition, neuroscience, and philosophy has illuminated the immense cognitive effort humans expend on such simulations and related feats, as well as the centrality of imagination to our human *niche* and evolutionary success (Bulley, 2021; Fuentes, 2020). While imagining simulations may seem like an inconsequential way for the mind to busy itself, a rapidly expanding body of literature has found that simulations are not just fleeting moments of mental noise. Instead, imagination can form everlasting traces—changing what and how we remember, altering our attitudes and preferences, and shaping our mental health. Accordingly, it is not surprising that imagination is an omni-present human phenomenon, occupying a large portion of our daily thoughts (Andrews-Hanna et al., 2010).

Although a thrust of literature in the last two decades has underscored the importance of simulation in its own right (e.g., Hassabis & Maguire, 2007; Schacter et al., 2007, 2017; Szpunar et al., 2014), much less attention has been given to the possible importance of the emotionality of such simulations (also see Blackwell, 2020). Yet, whether pleasantly anticipating a celebration or dreading the approach of a difficult conversation, simulations differ in their emotional content and are a ubiquitous aspect of

day-to-day life. In this review, we synthesize dispersed pieces of literature to highlight the impact of emotion in imagination, and we draw attention to important gaps in the literature, wherein the relevance of emotion remains to be clarified. We define emotional imagination as mental simulations for which emotion is a defining feature, transforming the fundamental nature of the event. Based on this definition, here, we review studies examining positive or negative emotional reactions towards or content in mental simulations. In doing so, we emphasize how emotionally charged simulations seem to hold adaptive relevance for humans, and touch on ways in which these adaptive consequences can go awry, or seemingly slip out of reach in individuals with mental health conditions. By elucidating the relationship between emotions and imagination, we provide novel insight into how humans can best harness this cognitive capacity for greater adaptive utility.

What is simulation

The concept of simulation

To unpack the relationship between emotion and imagination, we first turn to conceptualizations of imagination itself. Modern scientific thought on imagination was invigorated by works of the 1980's, in ideas of *mental time travel* (Suddendorf & Corballis, 1997; Tulving, 1985, 1991) and *memories of the future* (Ingvar, 1985)—although scientific interest in imagination has a long and rich history that spans academic disciplines (see Tulving & Szpunar, 2012 for review). Today, imagination is referenced in a variety of ways, with different terms capturing nuances in its temporal and episodic nature. Simulations can occur on different temporal scales; we can imagine what might happen five minutes or five years from now. Moreover, simulations

need not be oriented towards the future, but can also be oriented in the past or without any reference to a specific epoch (i.e., atemporal events; Hassabis & Maguire, 2007). Regardless of temporal frame, imagination varies in the extent to which episodic detail is generated, with some simulations consisting of rich and specific event-related details and others relying more so on semantic knowledge (D'Argembeau, 2015; D'Argembeau & Mathy; Irish, 2020; Szpunar et al., 2014). For example, *episodic future thought/thinking* (EFT; Atance & O'Neill, 2001), *episodic foresight* (Suddendorf & Corballis, 2007), and *prospection* (Gilbert & Wilson, 2007) capture future orientated imagination that conjure specific potential events while intention and goal-setting tend to reflect more abstract future orientated imagination (Szpunar et al., 2014, 2016). Similarly, *counterfactual events* are simulations of alternative events that might have been (Baron, 2000; De Brigard & Parikh, 2019; Schacter et al., 2015) while *nostalgia* captures simulations or thoughts of the past that are not necessarily tied to a specific event and center on the manifestation of desire or yearning in past reflection (De Brigard, 2017; Sedikides et al., 2008). In this review, we use the flexible term *simulation* (Schacter et al., 2008), with a large, albeit not exclusive focus on episodic simulations (particularly future ones), given the greater focus of research on this type of simulation.

Simulation is reconstructed memory

At the mechanistic level, simulations seem to arise from the flexible recombining of memories (Addis, 2020; Schacter, 2012; Schacter & Addis, 2007; Thakral et al., 2020). The malleability of memory is well established, and thought to be an adaptive function that allows us to disconnect elements from past events so that we can draw from and apply relevant information to a broad range of experiences (also see Schacter,

1999). These deconstructed segments of memories may provide the building blocks we use to construct novel simulations (Addis, 2020; Szpunar & McDermott, 2009).¹ This theoretical framework has grown in part from demonstrations of the striking parallels between episodic simulation and episodic memory. Neurally, both processes are supported by a ‘core’ network, including the medial temporal lobes, ventromedial prefrontal cortex, and lateral temporal and parietal regions (Hassabis et al., 2007; Schacter et al., 2007; Stawarczyk & D’Argembeau, 2015). At the cognitive level, episodic simulations share many phenomenological characteristics typically associated with memories, including scene construction (Maguire & Mullally, 2013; Mullally & Maguire, 2014), as well as other vivid mental imagery and a sense of re-experiencing (or “pre-experiencing”, in the case of future events; D’Argembeau & Van der Linden, 2004; de Vito et al., 2015). Both simulations and memories can be voluntarily brought to mind or can enter our minds spontaneously (Berntsen & Jacobsen, 2008; Cole & Kvavilashvili, 2021; Rasmussen & Berntsen, 2013). Simulations, like memories, are also weaved into daily life, coming to mind while we are participating in activities or resting, and whether we’re alone or surrounded by others (Barsics et al., 2016; D’Argembeau et al., 2011; see Figure 1). Although we spend a lot of time and cognitive resources engaged with memory, we spend even more time simulating the future (Baumeister et al., 2016). Note that while much emphasis is placed on parallels between episodic memory and episodic simulation, the critical role of semantic memory in episodic

¹ Interestingly, even memory itself involves imagination. When we recollect a past memory, we seamlessly use our imaginative abilities to color in the gaps in our memories (Johnson & Sherman, 1990).

simulation is also well recognized (D'Argembeau & Mathy, 2011; Irish et al., 2012; Irish & Piguet, 2013).

Figure 1. *Occurrence of Emotional Future Simulations in Everyday Life*

Note. Figure created based on Barsics et al. (2016), in which participants tracked the natural occurrence of emotional future simulations in their everyday lives. Figure 1a presents the context in which emotional future simulations manifested, while Figure 1b presents the activities participants were engaged in when emotional future simulations manifested.

Characteristics of emotional simulation

As simulations seem to be constructed largely from elements in memory, it follows that emotion would manifest frequently in simulations. Afterall, emotion is one factor consistently observed to enhance the salience and maintenance of memory (McGaugh, 2004). As many as 60% of future simulations have emotional content (D'Argembeau et al., 2011) and simulations of alternative pasts tend to revolve around how things could have been affectively better (i.e., upward counterfactuals) or worse (i.e., downward counterfactuals; Byrne, 2016). Imagination can conjure various *anticipated* emotional states in association with an upcoming event or plan (perhaps in the service of *affective forecasting*) as well as *anticipatory* emotions, as when we experience dread or excitement in the 'here and now' in association with an (un)favorable upcoming event (Baumgartner et al., 2008; Barsics et al., 2016). Notably, although simulations can clearly cause us to "pre-feel" our emotional responses to potential future events (Boyer, 2008), it is possible to conjure an emotional event in one's mind without actually *feeling* the relevant emotions (see Blackwell, 2020).

A wide variety of emotions can manifest in simulations, from joy and excitement to anger and sadness (Barsics et al., 2016).² In this section, we provide a brief overview of what is known about the characteristics of emotional simulations, thereafter turning to a discussion of the consequences of such simulations. While only a subset of studies have directly manipulated the emotionality of simulations, initial work hints that emotion may play a critical role in shaping simulations. For example, emotional simulations, whether positive or negative, are subjectively rated as more detailed than neutral ones

² Further exploration of how discrete emotions manifest in simulations is an important topic for future research.

(Acevedo-Molina et al., 2020). Moreover, studies have shown that positive versus negative simulations differ in their phenomenology. For example, simulated events infused with positive emotions are associated with more concrete spatiotemporal contexts, more vivid sensory phenomenology, and more episodic detail compared to negative simulations (Acevedo-Molina et al., 2020; D'Argembeau & Van der Linden, 2004; de Vito et al., 2015, but see Puig & Szpunar, 2017). Negative future simulations are more likely to manifest as inner speech whereas positive future simulations tend to be accompanied with mental imagery (Barsics et al., 2016). Interestingly, individuals with an absence of mental imagery (i.e., aphantasia; Zeman et al., 2015) experience diminished emotion when asked to imagine events, as indicated by a reduction of physiological responses during emotional simulation (Wicken et al., 2021; see Blackwell, 2020). Individual differences in imagery, therefore, may have consequences for simulating emotional experiences (also see Future Directions). Other work shows that details of positive simulations tend to be better maintained in memory, despite both positive and negative events forming long-term memory traces (Szpunar et al., 2012). Thus, just as memories can form the building blocks of imagination, imagination, in turn, can be harnessed to form vivid memories—the consequences of which are discussed below.³

Consequences of imaging emotional events

It is now well established that real-life emotional events cultivate vivid memories that can direct adaptive behaviour: Memories of negative experiences steer us away

³ Some work shows that the emotions manifested might depend on the imminence of the events being simulated (i.e., near versus far into the future). For example, thoughts about the far versus near future tend to be more positive in nature (see MacLeod, 2017).

from similar adverse situations, while memories of positive experiences encourage us to approach similar rewarding situations (Bell et al., 2015; Levine & Edelstein, 2009).

Though seemingly an adaptive consequence of emotional memory, in extremes, emotional memory can contribute to dysfunction (Dere et al., 2010). In light of the connections between memory and imagination, it is not surprising that emotional imagination may serve us in the same or similar ways. Below, we explore the relationship between imagination and emotion and how this relationship informs our attitudes, decisions, and behaviours. When possible, we show how the presence of emotion in imagination alters outcomes relative to neutral imagination. We also examine how the adaptive outcomes of imagination can, in some cases, keel into maladaptive territory.

Simulated emotional content shapes emotional reactions, and vice versa. Future simulations are more often positive than negative in emotional valence (Berntsen & Jacobsen, 2008; de Vito et al., 2015; Newby-Clark & Ross, 2003; but see Barsics et al., 2016). A bias towards foreseeing a positive future may contribute to individual resilience and perseverance (Ji et al., 2021b; Szpunzar et al., 2012), although it is also possible that the directionality is reversed. Interestingly, a more realistic (e.g., less positive) outlook of the future has been linked to depression (Marsh et al., 2019; Strunk & Adler, 2009) and anxiety (Hoerger et al., 2012; Wu et al., 2015), and positive future events tend to be less phenomenologically vivid in individuals with depression, anxiety, or dysphoria (Hallford et al., 2018). Furthermore, Ji and colleagues (2019) found that dysphoria was associated with fewer spontaneous positive simulations, a reduction driven by tendencies towards forming spontaneous negative simulations instead.

Interestingly, no difference in the frequency of neutral simulations was observed. Other work shows that suppressing simulations of worrisome events has been linked to reduced apprehension for the future (Benoit et al., 2016). Yet, cultivating vivid and detailed episodic future simulations of potential worrisome events has also been linked to adaptive emotion regulation strategies, such as problem solving and event reappraisal (Jing et al., 2016). While avoiding negative future simulations may prevent negative emotions from surfacing in the first place, engaging with such simulations when they do arrive may serve to reassure us of our ability to cope with what is to come. Past simulations may similarly contribute to maintaining a positive perspective on our life experiences. Indeed, imagining how situations could have been worse seems to cultivate feelings of relief and satisfaction with how things turned out (see Byrne, 2016). Still, individuals are more likely to manifest counterfactual events of how things could have been better in response to negative life events, a tendency linked to psychological distress and Post-traumatic Stress Disorder (PTSD) symptoms (Gilbar et al., 2010; Holmes et al., 2016; Kennedy et al., 2021).

Emotional simulations change attitudes/preferences. The relationship between emotions and simulation has downstream effects beyond mood states. Indeed, attitudes and preferences can be driven by the emotional content embedded in what we imagine. Recently, Paulus and colleagues (2021) asked participants to imagine running into people they liked, felt neutral towards, and disliked at a neutral location. While mere exposure to the location via simulation positively shifted evaluation of the neutral location, when holding exposure constant, imagining a liked person was associated with increased positive evaluation of the location and imagining a disliked person with

decreased positive evaluation of the location. This suggests that the emotional content of one element in a simulated event (the person) can be transferred to another element (the place). This phenomenon, often referred to as *transfer of valence*, is a well-documented learning mechanism at work during actual experiences (e.g., Hofmann et al., 2010; Palombo et al., 2021) but transfer of valence has only recently been observed during simulation. Other work by Mueller et al. (2019) likewise shows that aversive mental imagery paired with a neutral stimulus (i.e., a “conditioned stimulus”) can lead to a conditioned fear response, including increased subjective and objective indices of fear (also see Dadds et al., 1997; Jones & Davey, 1990; Soeter & Kindt, 2012 for work on imagination and conditioning). That is, *de novo* fear conditioning was observed in the absence of aversive physical stimuli. Notably, the transfer of valence effect in simulation has not been consistently observed for negative imagined experiences, with Benoit and colleagues (2019) reporting *increased* ratings of positive valence for neutral locations paired with disliked people, likely due to mere exposure effects. Still, the authors found that the shift in positive evaluations of the locations was stronger for places imagined with liked people.

While the observation that merely imagining an adverse event can lead to a transfer of valence effect is daunting, the power of imagination to extinguish an association holds incredible promise (e.g., see Holmes & Mathews, 2005; Wolpe, 1961). Indeed, therapeutic techniques harness this power through *de novo* exposure therapy—imagining anxiety-related content can extinguish phobias akin to real-life exposures in a range of anxiety disorders, including specific phobia, generalized anxiety, social phobia, and obsessive-compulsive disorder (Craske et al., 2014). Further, engaging with the

simulated exposure to increase its specificity and intentionally reframe negative content in a positive, or even benign way, may hold promise in alleviating anxiety, depression, and PTSD (Blackwell, 2021; Holmes et al., 2007).

Simulations not only alter our attitudes of places but they can also alter our attitudes and impressions of other people. Indeed, imagination can be used to create a host of alternative social realities, as demonstrated in work by Gaesser and his collaborators. For example, individuals are more likely to feel prosocial emotions such as empathy and compassion towards individuals in need when they engage in simulations that involve helping the person (Gaesser & Schacter, 2014). Note that this effect is specific to episodic representation and not information processing or semantic knowledge in general, as it is observed even in comparison to control conditions where participants conceive of ways the individual might be helped without simulating their own active involvement in helping. Further, while individuals are less likely to endorse intention to help out-group members compared to in-group members, engaging in episodic future simulations increases intentions to help and empathy for both ingroup and outgroup members (Gaesser & Fowler, 2020; Gaesser et al., 2020; Vollberg et al., 2021). This effect is strengthened when such helping simulations are infused with positive, compared to negative, emotional outcomes (Gaesser et al., 2017). Further, the amount of episodic specificity and vivid imagery generated during simulation contributes to this shift (Gaesser & Fowler, 2020; Gaesser & Schacter, 2014; Vollberg et al., 2021). Interestingly, while simulation may shift our attitudes towards others, simulations of acquaintances' futures are less likely to form positive events compared to simulations of one's own future (Salgado & Berntsen, 2020).

The tendency to simulate positive futures for ourselves may contribute to the construction of a positive self-concept. Just as some past events can form self-defining memories, people can readily identify episodic future simulations associated with core characteristics and beliefs about themselves (D'Argembeau, 2012; La Corte & Piolino, 2016). Such an ability is linked to a stable sense of self over time (e.g., temporal continuity; Demblon & D'Argembeau, 2017), while an inability to generate self-relevant future simulations is associated with a range of psychopathology, including PTSD (Brown et al., 2013) and mood disorders (Williams et al., 2007). Further, future simulations that involve picturing one's self accomplishing a desired goal are associated with more feelings of 'realness' during pre-experiencing as well as stronger emotional responses, compared to simulations of the self accomplishing something required of them (Ernst et al., 2018). Indeed, more detailed and positive goal-directed simulations have been associated with enhanced well-being, while goal-directed simulations with negative outcomes predict decreases in well-being (Gamble et al., 2021). Simulating not just positive futures, but positive future selves *per se* may serve as a beacon for us to work towards manifesting our ideal self (Sellitto, 2020).

Emotional simulations alter perceived probabilities. Simulating future events increases the perceived likelihood that the event might actually occur (see Koehler, 1991). Repeatedly simulating the same emotional event further enhances such perceived probability, an effect not observed in repeated simulation of neutral events (Szpunar & Schacter, 2013). The likely adaptive value of emotional imagination increasing perceived probability seems intuitive. That is, events that are perceived more likely to occur might be better prepared for and spontaneously remembered when an

opportunity arises to follow through with a delayed intention. Despite the adaptive value of increased perceived probability of emotional imagination, there are downsides as well. In an initial study on the topic, asking participants to imagine childhood counterfactual events (e.g., got stuck in a tree and had to have someone help you down) increased their confidence that those events had already happened (dubbed “imagination inflation; Garry et al., 1996; also see Mitchell & Johnson, 2009). This type of false memory may ironically lead to less preparation or anticipation of an opportunity to fulfill a goal.

How emotion contributes to the perceived likelihood ascribed to future events may also be influenced by some mental health conditions. For example, MacLeod and Conway (2007) observed deficits in the ability to construct personal, positive future simulations among survivors of parasuicidal events, perhaps reflecting an inability of such individuals to foresee positive events occurring in their lives. Individuals with depression and PTSD have deficits in constructing specific future episodes (Addis et al., 2016; Gamble et al., 2019; Hallford et al., 2020; Kleim et al., 2013), a finding that is consistent with the sense of foreshortened future often associated with these conditions (Holman & Grisham, 2020). Finally, while individuals tend to endorse that positive future simulations are more likely to occur than negative simulations (Acevedo-Molina et al., 2020, Barsics et al., 2016; Szpunar & Schacter, 2013), the opposite has been reported by individuals with anxiety (Wu et al., 2015)—perhaps contributing to worry and a sense of threat (Miloyan et al., 2019).⁴ Indeed, clinically anxious individuals report that it is

⁴Interestingly, future simulations frequently do occur: Spreng and Levine (2013) found that over half of participant’s episodic future simulations happened within a year while Weiler and colleagues (2010) found that 49% of holiday specific simulations occurred over the following winter break. Thus, simulation allows humans to tap into their future

easier to generate negative future simulations that might happen to them relative to non-anxious controls, a tendency that was further correlated with greater belief in the likelihood of these negative future simulations occurring (Raune et al., 2005).

Emotional simulations can change decisions. Over the last decade, research has also pointed to an intriguing relationship between simulation and decision making, particularly in the domain of intertemporal choices. It is well known that humans have a tendency to make decisions that forego larger future rewards in exchange for lesser immediate rewards (i.e., temporal discounting; Frost & McNaughton, 2017; Odum, 2011). For example, we may forgo saving for a summer vacation when the opportunity to spend a night out with friends presents itself. Future simulations have been found to temper temporal discounting, making individuals more likely to choose larger, later rewards despite the delay (i.e., reduced temporal discounting; e.g., Benoit et al., 2011; Peters & Büchel, 2010). Mechanistically, theorists have emphasized the importance of emotion, proposing that episodic future thinking might alter subjective value by providing individuals with a vehicle to ‘pre-feel’ the emotional value tied to the future and indeed, much of the earlier work on this topic involved participants simulating positive experiences. In doing so, individuals can more readily override the pleasurable emotions tied to the present reward, opting for larger, later rewards instead of smaller, sooner ones (see Boyer, 2008). Accordingly, simulations of positive events are more effective in attenuating temporal discounting relative to neutral events (Rösch et al., 2021).

reality. It is not yet clear whether the frequency of event occurrence is higher for emotional versus neutral events but such a hypothesis would accord with the observation that emotional simulation increases perceived event plausibility (see Main Text)—a topic for future research.

How negative future simulations influence decisions has been less consistent. One line of evidence suggests that negative simulations prompt people to choose immediate gratification (Liu et al., 2013; Zhang et al., 2018). As negative future events tend to be perceived as less plausible, it may be uncertainty of the likelihood of the imagined future that hampers patience. Alternatively, the unfavourable depiction of the future may thwart desire for future rewards. Yet, other evidence suggests that negative simulations attenuate temporal discounting. Perhaps, then, negative future simulations motivate individuals to invest in the future in order to acquire resources to prepare for and manage the future threat (see Ballance et al., 2021; Bulley et al., 2016, 2019; Calluso et al., 2019). In keeping with this idea, visualizing negative consequences of risky behaviours increases risk perception, while simulating positive consequences dampens risk perception—an effect that seems to be driven by affect above and beyond other components of simulations such as the vividness of the mental imagery elicited (Sobkow et al., 2016, also see Slovic et al., 1998). Note that opting for the larger, later reward is not always the wise choice ('a bird in the hand is worth two in the bush') but the role of imagination in adaptive *settling* has not been studied to date (see Bulley et al., 2020).

The potentially adaptive value of imagining a bleak future (i.e., simulating negative events) has been demonstrated outside the domain of temporal discounting. For example, Lee and colleagues (2020) showed that employing episodic future simulations to imagine climate catastrophe events led individuals to endorse more pro-environmental behaviour, an effect mediated by increased perceptions of risk after engagement in episodic simulation. Indeed, a lack of concrete mental imagery has been

identified as a possible explanation for the lack of climate action and it has further been proposed that eliciting imagery with emotionally salient external images may enhance motivation for climate action (see Boomsma et al., 2016)—possibly by allowing humans to play out hypothetical emotions. Cultivating a clear mental image of and feelings of sympathy towards a disadvantaged individual has been associated with greater intention to give and actual giving of charitable donations—although whether mental imagery or sympathy initiate this effect is unclear (Dickert et al., 2016). Similarly, Sinclair and colleagues (2021a) found that individuals who perceive themselves to be at low-risk of contracting COVID-19 were more likely to endorse not complying with public health guidelines. Yet, having individuals engage in episodic future simulations that involved imagining the consequences of risky behaviours (e.g., contracting COVID-19) shifted their willingness to follow public health guidelines—a change that was maintained at a 3-week follow-up session. Still, simulating events in which one causes someone harm may actually encourage antisocial behaviour; individuals tend to endorse a greater likelihood of engaging in acts that might harm others after simulating such events, an effect that may be partially driven by feelings of self-righteousness that can manifest when one justifies the harmful behaviour being simulated (Morris et al., 2022). Another study by Libby et al., (2007) found that simulation affected voting behaviour: Imagining voting led to participants subsequently adopting a stronger pro-voting mentality (as well as an increase in actual voting behaviour). Interestingly though, this was only observed when participants adopted a third-person or observer perspective (versus a first-person perspective) in their simulations, suggesting that the phenomenology of simulation might be relevant to promoting adaptive behaviours. As

noted by the authors, perhaps actually picturing oneself engaging in an event is more effective in changing one's perspective. It is possible that the emotional experience of envisioning oneself engaging in such social acts contributes to one's resolve to actually engage in the behaviour. In keeping with this idea, engaging with positive simulations of future rewarding experiences has been found to increase motivation and actual engagement in planned rewarding activities (Renner et al., 2019), an effect that may be driven by the influence such emotional simulations have on affect in the present moment (Ji et al., 2021a). In parallel, simulating adverse experiences of problem behaviours or addictions may help temper desire to engage in or cravings for substances when they manifest (May et al., 2015). Interestingly, while motivation to use a substance or engage in a behaviour may be stirred by pleasurable simulations of the potential experience, disrupting simulation may dampen motivation to obtain the substance and, in turn, engaging in the maladaptive behaviour (Andrade et al., 2012).

Notably, self-relevance in episodic future simulations seems to be a crucial element of the influence simulations have in our lives. Indeed, how vividly one can imagine their future self, how similar one's future self seems to the present self, and the emotional valence assigned to the future have a salient role in shaping decisions and behaviours (Hershfield, 2011). Hershfield and colleagues have shown that greater present-future continuity is associated with shallower temporal discounting (e.g., Hershfield et al., 2009; 2012; 2018). That is, a stronger connection to one's future self may foster greater patience. Further, considering one's future self may reduce delinquent behaviour (van Gelder et al., 2015) and substance use (Wang et al., 2019), especially when individuals predict what emotions might be encountered as a result of

their behaviours (see Rafei et al., 2021), again highlighting the importance of emotion. More broadly, these studies show the power and perils of emotional imagination in real-world contexts (also see recent work by Brevers et al., 2021; with comment from Williams & Benoit, 2021).

Summary

The evidence is clear that emotional simulations influence our lives in many ways (Figure 2). By shaping our attitudes, decisions, and behaviours, imagination has vast implications for promoting well-being for both individuals and society. By harnessing positive episodic future simulation, we may adopt a resilient and optimistic perspective, alter our preferences towards our surroundings, harbour prosocial attitudes, make more patient choices, and engage in more conscientious behaviours. Albeit somewhat paradoxical, negative simulation can lead to more adaptive choices to the extent that it helps an individual avoid unwanted outcomes. However, the powerful impact of emotional episodic future simulations may have some less adaptive consequences as well, and may contribute to mental health distress. Making the future feel more plausible may not be beneficial if the simulations we construct are stressful or threatening—particularly if we engage in such simulations without harnessing appropriate coping or emotion regulation strategies (e.g., problem solving, reframing; also see Benoit et al., 2016). Further, the immersiveness of self-relevant simulations may be detrimental if one has lower self-worth and is engaging in simulations that reinforce such negative beliefs. It is also possible that romanticizing or justifying outcomes of maladaptive behaviours (via simulation), such as social status gains from binge drinking or moral justification of harming others, may encourage engagement in unhealthy or harmful behaviours.

Finally, struggling to engage in positive emotional imagination may reinforce feelings of depression, and prolong anxiety and stress disorders, including PTSD. The way we frame the content of emotional simulations likely informs the consequences.

Figure 2. *The Consequences of Emotional Simulation*

Note. Schematic of proposed format and consequences of emotional simulation. Here we show how emotional simulation is constructed de novo from memory. The format of the simulation depends on various properties (e.g., scene construction, episodic detail, etc.). In turn, an emotional simulation - in this case a negative one - can inform a host of cognitive processes, including memory, attitudes, etc. For proof of concept, real life examples of adaptive and maladaptive consequences are provided. The semi-transparent top to down arrow depicts the complex (and at times reciprocal) relationships between various cognitive processes. Image taken from iStock, with permission.

Future Directions

A number of important questions remain for future research to explore. First, while evidence suggests differences in the phenomenology and frequency of emotional versus neutral simulations (e.g., Acevedo-Molina et al., 2020; D'Argembeau et al., 2011), further comparisons of how emotional simulations differ from neutral ones is warranted. For example, the consequences of simulations may differ for neutral simulations, perhaps dampening the impact of imagination or offering alternative functions altogether.

Further, although it is clear that emotional imagination can either be deliberate or involuntary, it is less clear whether some of the downstream effects of imagination that we observe in the laboratory occur spontaneously in real life. Indeed, simulation is typically assessed in laboratory settings by requesting participants to imagine a specific scenario, or generate a simulation from cue words. While work employing alternative approaches, such as diary or experience sampling methods, have shown important characteristics of naturally occurring simulations, the consequences of such simulations remain less clear. For example, can a fear of snakes arise from merely imagining (or dreaming) experiencing a snake bite or playing out the event in the mind vicariously after a loved one's encounter (also see Mueller et al., 2019 for discussion)? And, if so, do simulations precipitate full-blown phobias or just subtly colour our appraisals and experiences? Further, it is unknown whether such imaginative conditioning effects are transient or if they form enduring memories. Interestingly, some recent work suggests that highly anxious individuals are less likely to remember emotional (both positive and negative) future simulations than less anxious individuals—a difference not observed for neutral simulations (Montijn et al., 2021). Future work should seek to elucidate whether

worry is perpetuated in anxious individuals due to forgetting simulations that might otherwise facilitate emotion regulation strategies, perhaps due to discrepancies in the self-relevance of positive future simulations.

Next, although our review provides some examples of the use of imagination to foster adaptive real-life behaviours, it is not clear yet what aspects of imagination are most effective. As reviewed above, cultivating vivid mental imagery or scene-based processing when engaging in episodic simulations seems to enhance the effects of emotional imagination, suggesting it may be a vehicle by which we experience or anticipate emotions. Here we focused on episodic imagination, but humans also conceive of their future semantically and such semantic simulation may confer adaptive benefits for humans. It may be that while both forms of simulation are beneficial, episodic simulation may be more robust in driving emotion (Boyer, 2008). Other work in the realm of mind wandering shows that the role of emotion depends on the nature of the thoughts *per se*. For example, compared to task-related thoughts, task-unrelated thoughts (i.e., when the content of thoughts move away from the task at hand to another topic) tend to be less positive in valence whereas freely moving thoughts (i.e., when thoughts flow through a range of topics unconstrained) are associated with more positive valence (Mills et al., 2021). Although mind wandering has been linked with episodic future thinking (e.g., Smallwood et al., 2009), how these valence effects interact with the episodicity or temporal orientation of the thoughts themselves remains to be elucidated. Given the frequency of human mind wandering, this is an important area of research.

More work is needed to determine what other aspects of real world behaviours emotional simulation augments. Here we provided evidence for improvements in prosocial and choice behaviours, but there might be other benefits. For example, literature shows that episodic simulations have a positive influence on prospective memory (our ability to remember to carry out a future intention; Altgassen et al., 2015)—whether emotion moderates this link ought to be examined. Relatedly, research in goal achievement shows that individuals are more likely to follow through with goal-related intentions, such as dieting and other health-related actions (e.g., smoking cessation; see Athamneh et al., 2021), when they have considered concrete actions to move toward goal attainment, and perhaps overcome situations that might impede goal attainment (i.e., an if–then plan; see Gollwitzer & Sheerna, 2006; also see Taylor et al., 1996 for a similar finding in the context of school exams). Given the evidence reviewed above, we might expect that engaging in positive (simulating the rewards associated with carrying out an action) or even negative episodic simulation (simulating the consequences of not carrying out an action) when setting intentions would be a particularly salient way to manifest goals, though research is needed to confirm such hypotheses and understand the role of imagination inflation.

How emotional imagination varies over the life course is another area for future work to explore. While imagination has been identified as a crucial contributor to the development of social skills in children—through avenues such as pretend play and imaginary friends (Chernyak et al., 2017; Davis, 2020)—the role of emotion in such simulations has yet to be directly explored. In contrast, recent research has examined emotional simulations at the other edge of the life course; in older adults. Similar to what

is observed in memory, older age is associated with reductions in episodic simulations while simulations more semantic in nature seem to remain intact (Addis et al., 2008, 2010, 2011). The influence of emotion in episodic simulations does not seem to differ by age, when comparing young versus older adults (Acevedo-Molina et al., 2020), however the overall lack of episodic simulation may restrict access to the adaptive benefits emotional simulations can produce. Aging has been found to temper the influence of simulation on prospective memory (Terret et al., 2016), prosociality (Gaesser et al., 2017), and temporal discounting (Mok et al., 2020). Still, access to and engagement in semantic future simulations may contribute to a more positive outlook in older, compared to younger, adults by distancing oneself from negative future simulations (Devitt et al., 2020; also see García-Bajos et al., 2017) and thinking of experiences with a more holistic, 'big picture' perspective (Gaesser et al., 2011; also see Scheibe & Carstensen, 2009). Interestingly, Sinclair and colleagues (2021b) found that older adults benefited from imagining personalized scenarios in relation to the COVID-19 pandemic, whereby endorsement of public health behaviours increased following simulation of personally-relevant and negative COVID-19 events.

Finally, not all individuals possess the same capacity for imagination and what the consequences of these individual differences might be remains unknown. For example, individuals with low imagery or mnemonic abilities, may be protected from potential maladaptive outcomes of simulating negative events (see Dawes et al., 2020; Palombo et al., 2018). Still, the adaptive and in some cases therapeutic effects of simulation may not be available to these individuals. Effectiveness of de novo therapeutic techniques should take into consideration individual differences in

simulation abilities and one's ability to conjure emotions when simulating, which may or may not diverge from mental imagery ability. At the other extreme, individuals with particularly vivid imaginations may be more susceptible to maladaptive consequences of simulations. It is possible that the plausibility of future simulations and the salience of the memory for a simulation may contribute to false memories (see Newman & Lindsay, 2009; Schacter et al., 2011) and confusing what we intend to do with what we might have already done (Johnson & Sherman, 1990). Yet, hyper-imaginative abilities may confer some benefits, perhaps in the domain of emotion regulation or creative cognition, such as creative writing or directing. Still, imagination comes in many forms and formats, with some individuals perhaps excelling in visual imagery, whilst others tend to be more non-imagistic. The consequences of such individual differences are starting to be elucidated.

While there is much for future research to explore, the current state of the literature clearly indicates an important relationship between emotion and episodic simulation. Such evidence lends support to emotional simulation as an emerging construct in the field. Conceptualizing emotional simulation as a construct opens exciting theoretical avenues to build on earlier work highlighting the important relationship between memory and simulation (e.g., Addis, 2020; Schacter & Addis, 2007) by tracing potential parallels between emotional memory and emotional simulation. Indeed, should memory provide the building blocks for simulations, we might expect the fingerprints of emotional memory, along with its associated characteristics and mechanisms, to be present in emotional simulation. Emotional memories may be prioritized in memory systems in order to facilitate the construction of emotional

simulation, and access simulations as a powerful cognitive tool. Moreover, the emotional regulation strategies that are effective for memory seem to hold promise for future simulations as well (Benoit et al., 2018), suggesting that their parallels should be closely considered. How other key findings translate, between emotional memory and emotional simulation, as well as between emotional simulation of different temporal-orientations (future, past, or atemporal) will be important to consider.

Closing Remarks

The present review considers burgeoning and well-established research in emotional imagination, summarizing evidence to suggest that simulations infused with emotion may have a particularly salient influence over our mood states, attitudes and preferences, and decisions. We explore the ways in which this influence can instigate adaptive behaviours by nudging us towards long term individual and communal goals. However, such beneficial results are contingent on caveats; from how positive our sense of self is to how we appraise different behaviours. Indeed simulations may foster maladaptive outcomes if used to reinforce negative thoughts or ruminate on dismal futures. There are many exciting avenues for future research to further our understanding of how different contexts as well as individual differences may influence the outcome of emotional simulation. In doing so, we can harness the adaptive powers of emotional simulation, and potentially resist the perils that might otherwise engulf us.

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