

## Sueños, trauma, y errores de predicción

### *Dreams, trauma, and prediction errors*

Clarita Bonamino<sup>\*</sup>; Sophie Boudrias<sup>\*\*</sup>; Melanie Rosen<sup>\*\*\*</sup>

<sup>\*</sup>Queensland University of Technology, Australia

clarita.bonamino@gmail.com

ORCID: 0000-0002-8843-4211

<sup>\*\*</sup>Université du Québec en Abitibi-Témiscamingue, Canadá

Sophie.Boudrias2@uqat.ca

ORCID: 0000-0002-4548-3689

<sup>\*\*\*</sup>Trent University, Canadá

melanierosen@trentu.ca

ORCID: 0000-0002-7545-5558)

### Resumen

Es ampliamente conocido que los sueños pueden ser fuertemente afectados por eventos traumáticos, pero puede haber otras formas en las que los sueños se relaciona con el trauma. En este artículo, argumentamos que diferentes tipos de sueños podrían contribuir tanto al trauma como a aliviarlo, según los errores de predicción que ocurran ya sea en los sueños o en la respuesta a los sueños después de despertar. Un error de predicción ocurre cuando una experiencia contradice la expectativa que uno tiene, y a menudo está acompañado por sorpresa. Los errores de predicción están involucrados en procesos de actualización de la memoria que pueden ser duraderos. No solo las pesadillas, sino también los sueños desagradables y, sorprendentemente, incluso los sueños neutrales y agradables tienen el potencial de contribuir al trauma, afectando nuestra vida de vigilia de manera similar a las experiencias traumáticas que acontecen en vigilia. Postulamos que ciertos sueños también pueden ser beneficiosos para aliviar el trauma. Además, la evidencia clínica sugiere que trabajar con los errores de predicción que ocurren en los sueños y durante nuestra respuesta a los sueños después de despertar puede ayudar a aliviar los efectos negativos del trauma.



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**Palabras clave:** sueños, trauma, error de predicción, reconsolidación de la memoria, sueño lúcido, pesadilla, memoria, trastorno de estrés postraumático.

### Abstract

It is widely known that dreams can be strongly affected by traumatic events, but there may be other ways in which dreams relate to trauma. In this paper, we argue that different types of dreams could both contribute to trauma and alleviate it according to the prediction errors that occur either in dreams or in response to them after waking. A prediction error occurs when an experience contradicts one's expectation and it is often accompanied by surprise. Prediction errors are involved in memory updating processes that can be long-lasting. Not only nightmares but also unpleasant, and surprisingly, even neutral and pleasant dreams have the potential to contribute to trauma, affecting our waking lives in a similar way to waking traumatic experiences. We postulate that certain dreams can also be beneficial for trauma alleviation. Further, clinical evidence suggests that working with prediction errors that occurred in dreams and during our response to dreams after waking can assist in alleviating the negative effects of trauma.

**Keywords:** dreams, trauma, prediction error, memory reconsolidation, lucid dream, nightmare, memory, post-traumatic stress disorder.

## 1. Introduction

The relationship between dreaming and trauma is often explored from the perspective of how trauma influences dreams. Nightmares and unpleasant dreams are clinically recognized *responses* to traumatic events (American Psychiatric Association [APA], 2013). However, less is known about the contribution of dreams themselves to trauma and whether dreams can play a role in alleviating it. Here we discuss the surprising ways dreams may contribute to and alleviate trauma, focusing in particular on the role that prediction errors (PEs) play in these experiences.

While the negative effects of nightmares on our waking lives are well known, we draw on this literature to make a case for such dreams at times being trauma contributing. Further to this, beyond nightmares, we argue that even unpleasant, neutral, or pleasant dreams could contribute to trauma in unexpected ways. Throughout this discussion we refer to dreams as 'contributing to trauma' and emphasise their trauma-like effects on the waking lives of dreamers rather than delving into the question of whether we should categorise such dreams as a type of trauma. Part of what could make dream experiences trauma-contributing is the PEs that occur in dreams or after waking. PEs can contribute in several ways, including surprise that shocks the dreamer awake during nightmares. Memories of nightmares after



waking can then conflict with previous convictions that it is safe to fall asleep, leading to insomnia. Undesired or unexpected emotions or unpredicted, out of character behaviour experienced in neutral or pleasant dreams can lead to guilt, shame, or the questioning of one's waking relationships.

Through PE processing, dreams can play a dual role, both as potential contributors to trauma and as tools to alleviate it. In the final section, drawing on evidence from clinical therapeutic practice (Boudrias, 2024), we discuss ways in which PEs can be utilised with dream memories to alleviate trauma.

Dreams, we argue, can induce trauma-like effects as well as worsen the effects of waking trauma, and PEs can play an important role in these effects. We begin by outlining the relationship between PEs and trauma via memory reconsolidation.

## 2. Prediction errors and trauma

Den Ouden et al. (2012, p. 2) define PE as “the mismatch between a prior expectation and reality”, which influences perception, cognition, decision-making, learning, and memory. They distinguish between various types of PEs, specifically perceptual and cognitive PEs, characterised by no specific affect valence, and motivational PE, characterised by valence. Due to the non-experimental nature of this paper, perceptual PEs are not the focus here, as typically they are studied in a laboratory setting through generation of a single perceptual input. Given that traumatic experiences often reach high levels of cognitive and affective complexity, the term PE in this paper specifically refers to cognitive and motivational PEs. Cognitive PEs occur when a sequence of events unfolds in an unexpected way, resulting in the updating of the former representations of the self or the world. Motivational PEs involve an affective valence, either pleasant or unpleasant, resulting in two further subtypes: appetitive PEs, which relate to reward, and aversive PEs, which relate to fear and punishment (Den Ouden et al., 2012).

Trauma can arise from “any disturbing experience that results in significant fear, helplessness, dissociation, confusion, or other disruptive feelings intense enough to have a long-lasting negative effect on a person's attitudes, behaviour, and other aspects of functioning” (American Psychological Association, 2018b). A paradigmatic case of trauma is Post-Traumatic Stress Disorder (PTSD), a psychiatric disorder emerging subsequent to an event involving “actual or threatened death, serious injury, or sexual violence” (American psychiatric association, 2013). While traumatic events can cause PTSD, this is not always the case. More broadly, trauma may also arise from painful events, not only those involving death, injury, or sexual violence, but from any aversive event consolidated as a lasting emotional memory that impacts cognition, mood, or behaviour, and generates distress or functional impairment. Memory processes are at the core of trauma, PTSD, and other



aversive experiences. These processes often manifest as involuntary memories, such as flashbacks and nightmares (APA, 2013). Besides memory enhancement due to the physiological arousal accompanying aversive events, the unpredictability of such events has been shown to independently contribute to the emotional enhancement of memory (Kalbe & Schwabe, 2020). For example, if one expects to be safe in a familiar street but instead is confronted by an aggressive person, this unexpected and frightening event may prompt a new emotional associative memory, linking that street to danger.

Associative emotional memory is the binding between two components of an emotional experience (e.g., ‘this street’ and ‘danger’). This associative learning relies on PEs (Iordanova et al., 2021). In the previous example, the person who was attacked on a street may feel fear the next time they walk there, predicting danger. This can lead to avoidance behaviour and affect daily functioning (APA, 2013). The memory reconsolidation process is a process through which a memory becomes destabilised and can be updated (Nader et al., 2000). This process may be particularly valuable for updating traumatic memories into less aversive ones (Schiller et al., 2010). Many animal and human experiments on reconsolidation have successfully targeted aversive memories in this way (Alberini & LeDoux, 2013). Before the recent discovery of the memory reconsolidation process, a consolidated memory was thought to be stable over time (Alberini & LeDoux, 2013). Memory reconsolidation is now known as the neuronal mechanism through which a consolidated memory can be updated in a long-term way that will not revert to the old, consolidated memory (Monfils et al., 2009; Nader et al., 2000). In contrast, other mechanisms such as fear extinction are, for some theorists, described as short-term alterations that eventually lead to the return of the fear memory (Monfils et al., 2009). According to the memory reconsolidation framework, when a previously consolidated memory is reactivated with a PE, it returns to a labile state within a ‘reconsolidation window’ of six hours, during which it is susceptible to updating (Nader, 2003; Pedreira et al., 2004). A PE in this context is an experience that contradicts the memory. For instance, if a person who has learned to fear a particular street walks down the same street again, this would likely reactivate their fear memory. Within the six-hour reconsolidation window of this memory reactivation, experiencing a clear sense of safety or even some pleasure in response to this street could lead to a prediction error between the feared outcome and the actual outcome, thus destabilising the former fear memory. The different components of the experience are assessed in relation to the former expectations to determine whether there is a disparity between the previously learned expectation and the currently experienced reality. A PE occurs when there is a “difference between the presented outcome and prediction made. It represents how surprising and certain was the outcome of the prediction made” (Fernández, Boccia, & Pedreira, 2016, p. 425). PEs enable the subject to better adapt to the current situation. The reconsolidation framework describes the updating of implicit emotional memories that cause and maintain various symptoms and

mental health disorders including PTSD and this framework has become increasingly influential in psychotherapy (Dhalitz & Hall, 2015; Ecker et al., 2012; Lee et al., 2017).

### 3. Dreams

Dreams are “a physiologically and psychologically conscious state that occurs during sleep and is often characterized by a rich array of endogenous sensory, motor, emotional, and other experiences” (American Psychological Association, 2018a).<sup>1</sup> Typically, while dreaming, dreamers believe their experiences to be real. Just like waking experiences, dreams can be psychologically impactful in a variety of ways. For instance, dream mood and content can predict one’s waking mood (Mallett et al., 2022), and increased anxiety and other negative emotions have been reported on mornings following a nightmare (Köthe & Pietrowsky, 2001). Here we argue that different types of dreams could both contribute to trauma and help alleviate it, in part due to the predictive processes involved within the dreams or occurring during wakefulness in response to them. In the present paper, six dream types are identified and discussed in relation to trauma: nightmares, unpleasant dreams, neutral dreams, pleasant dreams, visitation dreams, and lucid dreams (see Table 1 for definitions).

Within a single dream, one could encounter one or a combination of dream types. For example, a dream might manifest as a blend of lucidity, visitation, and pleasantness, such as having a pleasant dream of one’s deceased grandmother while being aware one is dreaming. Dreams can also transition between types, for example, beginning as pleasant, and later evolving into an unpleasant dream experience (e.g., if, later in the pleasant dream about grandmother, the dreamer and their grandmother are attacked by wolves). In the following sections, we begin by presenting the relation between dreams and memory processing, including PE processing. We then discuss the possible contribution of dreams to trauma and the extent to which they can be used to alleviate it through PEs.

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<sup>1</sup> There is considerable disagreement about the nature of dreaming, with debates on whether they should be considered hallucinations or imagination (see Rosen, 2024, chapters 4 and 5 for an overview) and even what dreaming is like from the first-person perspective (Carruthers et al., 2019). However, for the purpose of this paper, we will consider dreaming as a form of experience occurring during sleep that is usually mistaken for reality, and not weigh in on the imagination vs hallucination debate.



| Dream types       | Definition  |
|-------------------|---|
| Nightmares        | Dreams that incite anxiety, fear, or other dysphoric emotions that cause awakening (Levin & Nielsen, 2007).                                 |
| Unpleasant dreams | Dreams characterised by dysphoric, disturbing, unpleasant, or negatively toned features, but these features do not cause awakening.         |
| Neutral dreams    | Dreams that evoke neutral valence (e.g., neither pleasant, unpleasant, or nightmare-like).  |
| Pleasant dreams   | Dreams that evoke hedonic, enjoyable, or other positive emotions, feelings, or experiences.   |
| Visitation dreams | Dreams during which the dreamer has an encounter with deceased relatives, loved ones, or ancestors (Nordin & Bjälkebring, 2021).            |
| Lucid dreams      | Dreams during which one is aware of experiencing a dream and the dreamer may have the ability to influence oneiric content (LaBerge, 1985). |

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*Note.* Table 1 defines the types of dreams that will be discussed in relation to trauma.

### 3.1 Dreams and memory processing

The possible role of sleep and dreams in memory reactivation, consolidation and reconsolidation is widely studied (Diekelmann et al., 2009; Picard-Deland et al., 2023; Wamsley & Stickgold, 2019; Zhao et al., 2018). In a review about memory reactivation during sleep, Picard-Deland et al. (2023) state that, “as observed for memory reactivations, dreams preferentially incorporate novel, emotionally intense, and personally meaningful experiences” (p. 572). Novelty, emotional intensity, and personal meaningfulness are also characteristic features of trauma. Further, nightmares related to previous waking trauma often replay the traumatic memory as it is remembered (Foulkes et al., 1989), while other dreams rarely replay waking experiences (Hartmann, 2010).<sup>2</sup> Evidence from research and clinical practice shows that working directly with client’s nightmares, for example, through Imagery Rehearsal Therapy, can help reduce PTSD symptoms, including nightmare frequency (Krakow & Zadra, 2006).

Sleep disturbances may predict the emergence of PTSD (Bryant et al., 2010; Koren et al., 2002; Mellman et al., 2002; van Liempt et al., 2013). However, van der Heijden and colleagues (2022) propose that theoretically, if sleep and dreams enhance memory consolidation, sleep disturbances may also be considered a PTSD preventive intervention that can disrupt trauma-related memory consolidation immediately following a waking traumatic event. They posit that short-term insomnia following waking trauma might help prevent the consolidation of the trauma-related memory as opposed to being considered a symptom in need of immediate eradication. Nonetheless, sleep and dreams after a therapy session could also be part of PTSD treatment, as they may enhance the impact of the emotional memory update previously facilitated by the therapy session (Lane et al., 2015). To make a case for dreaming as a contributor to trauma, we discuss how the occurrence of PEs in dreams may be involved.

<sup>2</sup> In this work, Hartmann also argues that PTSD dreams are rarely, if ever, *exact* replays of memories — the examples he cites always involve one or more elements of the original experience being altered.



### 3.2 Prediction errors in dreams

Current neuroscience research indicates that PEs not only increase the consolidation of emotional memories (Kalbe & Schwabe, 2020) but are also essential for the long-term updating of previously consolidated memories through reconsolidation (Pedreira et al., 2004). We posit that PEs can arise either during a dream or as a response to the dream after waking when the dreamer experiences an emotional response to it.

According to Hobson and Friston (2012), our waking sense of agency relates to ‘prediction error minimisation’ and the dreaming brain continues to generate sensorimotor predictions in a state that involves very little sensory input. When we navigate the environment, data in the form of sensory input conflicts with hypotheses that the mind makes about what will occur. Due to their internally generated nature, Hobson and Friston (2012) postulate that dreams “do not elicit sensory surprise (startle) because they are not constituted by precise sensory prediction errors” (p. 94). However, dreams can indeed be surprising and can involve certain types of PEs in the general sense of PE discussed here.<sup>3</sup> We can experience not only decreased sense of agency and failed actions but also be surprised by these struggles (Rosen, 2015, 2018). Since a surprise reaction occurs when something deviates from one’s expectations, surprise is often the emotional experience that accompanies PEs (Holmes & Nolte, 2019; Solms, 2015). The dream database (sleepanddreamdatabase.org), for instance, reveals over 50 examples of the word “startled” alone, for example, “I dreamed that I was with a bunch of girls from BW. [...] Just as I was about to sit down, I saw one of my old boyfriends and I was startled and woke up.” (Hall & Van de Castle Female Norms 1947-1950 hvdc\_f0, 09-03-2012).

The following example from a dream report is a *motivational* PE, as it is characterised by valence: “Friedrich comes to visit, and stays overnight. He wants to cuddle with me. I’m surprised and delighted” (2020\_dreams: melvin, sleepanddreamdatabase.org). This dream illustrates the dreamer’s unmet expectations, leading to a pleasant surprise in response to Friedrich’s desire. Nightmares can also be surprising and involve prediction errors that can startle the dreamer awake. Some surprises in dreams may be caused by externally generated stimuli, such as random eye movements and unexpected noises ‘infiltrating’ the dream. While asleep, we can feel our real muscles tensing, eyes moving, hear a car backfiring, or experience sensations from the bedsheets. These sensations can be unpredictable and surprising

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<sup>3</sup> We think it is plausible that dreams can also generate sensory startle, contrary to the arguments made by Hobson and Friston (2012). Sensory PEs such as fumbling and thwarted intentions appear common in dreams (Rosen, 2021a), however, for our purposes here, the general sense of PE and surprise is the focus.



(Dennett, 1976). Such infiltration is common (Windt, 2015, 2017), suggesting that surprise caused by sensations from the environment can occur relatively regularly.

However, it is plausible that we can experience PEs or surprise in response even to internally generated dream events and sensations, not only sensations that filter into the dream from the sleeping body. For example, nightmares can surprise us when an unexpected, scary event occurs or an object appears (Nielsen & Levin, 2007; Nielsen & Zadra, 2011; Robert & Zadra, 2014) — in fact, being woken by surprising or scary content is part of what makes a dream a nightmare (Blagrove et al., 2004). While, undoubtedly, some visual stimuli, like light and colours, can ‘infiltrate’ the dream, it is unlikely that many visual experiences are primarily caused by the external world. After all, our eyes are closed, and the filtered-in light alone is unlikely to account for the complex visual experiences that are reported during dreaming (Windt, 2015, 2017). The visual scene, as we argued, can be both surprising and internally generated. This suggests that surprise and PEs in dreams may arise from either external stimuli or internally generated dream sensations, objects, or events. In support of this, Ecker and colleagues state that therapy using imagination “can be so effective [in the therapeutic memory reconsolidation process] because the emotional brain responds to imagined experiences almost indistinguishably from how it responds to physically enacted experiences” (2012, p. 115). If a PE that consolidates memory can arise from imagination, this supports the idea that external stimulus from the physical world is not required to update a memory. Our internally generated states can indeed be surprising as reflected by our emotional responses to them. Dreaming in particular can likely be quite surprising despite its internally generated nature because, unlike imagination, we typically believe the dream to be really occurring.

In waking life, surprise can arise from bizarre, uncommon stimuli or events. Some theorists attribute dreamers’ inattention towards bizarre dream elements or lack of ‘surprise’ to altered cognitive and neural mechanisms. These include a reduction of attention and rational capacity often associated with non-lucid dreams (Kahan & Sullivan, 2012; Yu & Shen, 2020) and the deactivation of the dorsolateral prefrontal cortex (Maquet et al., 1996) linked with a reduction of higher-order thought, attention, and metacognition (Qiu et al., 2018). Despite these alterations to our cognitive resources (Kubota et al., 2011; Voss et al., 2013), dreams can still evoke surprise. There is also ongoing disagreement about the extent of bizarreness within dreams (Rosen, 2018). Further to this, what we find bizarre while awake may differ from what we find bizarre while dreaming. For example, one of the authors recounts a dream where she was surprised to find herself crying while witnessing her brother melting until only his head remained. Such an event would certainly be shocking if it occurred in waking life, however, the author would likely be surprised by the event itself, rather than her emotional reaction — the surprise would stem from witnessing her brother



melting, not from crying in response to the situation. The upshot is that while surprise can occur in dreams, our surprise might differ from what occurs while awake, and this can evoke PEs after waking when we are surprised by unexpected dream responses and behaviours.

Hence, despite the altered cognition that occurs in dreams, it seems hard to deny that we can be surprised when we dream. We argue that surprise doesn't only occur in response to nightmares but rather it can manifest in a variety of ways during dreaming, as suggested in the earlier example where the dreamer experiences delight in response to Friedrich's desire to cuddle. Further, the fact that dreamers can struggle, have their intentions thwarted and feel out of control (Rosen, 2021b) can generate surprise. Beyond the PE processing involved in memory reconsolidation and the surprise reactions noted in dream reports, we argue that dreams may both contribute to trauma and help alleviate it. While we do not wish to argue that PEs are necessary or sufficient for trauma to occur, they can play an important role.

#### 4. Dreams' contribution to trauma

Whether a waking event can induce or contribute to trauma depends on several factors, not only the nature of the event but also the person's traits, characteristics and prior experiences. Sociocultural factors and the personal significance and meaning attributed to that event can also play a key role (Castro-Vale et al., 2020). Two individuals can be exposed to the same event but respond to it differently — one is traumatised while the other is not. It can be argued that similar factors may influence whether dream experiences can impact wakefulness in a way that could be considered trauma-contributing. Despite being a construct of the dreamer's mind, the events that occur while we dream can feel real to the dreamer and these events can evoke intense emotional responses (Rosen & Trakas, 2024). Emotions that occur during dreams can carry over to wakefulness (Lara-Carrasco et al., 2009; Mallett et al., 2022; Schredl & Reinhard, 2010), but we can also experience strong emotions as a response to the dream after waking (Boudrias, 2024). The relationship between dreams and waking trauma is complex and can be difficult to predict. Similar to waking events, both the dream content and the response to the dream occurring after waking could contribute to trauma. For example, a dream in which one is surrounded by playful dogs will affect a person who loves dogs differently than a person who fears them, both within the dream and after awakening. The frequency of a dream experience might also play a role in its impact. Recurrent nightmares are associated with heightened waking distress (Spoormaker, 2008) and the fear of having the same nightmare again can lead to resistance to falling asleep. Additional factors including an individual's overall psychological state, support system, personal beliefs, and cultural and religious attitudes may also influence one's response to dreams and their potential contribution to trauma. For example, some Aboriginal Australian cultures view dreams as messages from the spirit world or as having a significant predictive value (Den Boer, 2012; Peile, 1997). Among the Kukatja people of Western Australia, for

instance, there is a belief that dream events may be a cause or contribute to sickness: “In my dream a wild dog bit me. Directly, I will become sick” (Peile, 1997, p. 118).

A further consideration pertains to the ethical aspects of dreaming. Smuts (2016) proposes three interrelated types of moral evaluation for imagined or dreamed events: the right, the good, and the attribution of moral responsibility. Upon awakening from a dream, a person might question whether it was ethical for them to have engaged in or enjoyed particular dream activities. They might also ask themselves whether it was good or bad to have had that dream and whether they should be held accountable for the experience. For example, one may feel deeply disturbed after dreaming of having ecstatically tortured others. This dream experience can lead to PE that occurs after waking for individuals who do not recognize themselves in such actions. Considering that in some dreams we lack the cognitive ability to recognise whether a dreamed activity is morally acceptable, blaming someone for experiencing such a dream could be considered absurd. Nonetheless, we may still awaken feeling morally responsible for actions we dreamed of committing that contradict our personal beliefs, and there may even be instances where we have good reason to assign moral blame to some dreamed behaviours. Cowan, (2023) for example, argues that lucid dreamers who intentionally commit immoral acts in dreams are such a case. This feeling of moral responsibility concerning one’s dream might contribute to trauma.

Each person’s experience with their own dreams and their subsequent response is unique and highly subjective. A dream would contribute to trauma if the dream or the dreamer’s response to it affects their cognition, mood, or behaviour in a way similar to the effects of waking trauma, leading to distress or functional impairment after waking. We posit that this can occur via PE processing which manifests either during the dream itself or in response to the dream after awakening. For instance, in the former, one might have a dream of taking a walk through a familiar park and anticipating seeing a tranquil lake. However, upon nearing the lake, they instead discover a stormy sea filled with monstrous creatures, thus creating a PE. Alternatively, PEs can occur post-dreaming. Consider dreaming of intentionally hurting someone. After awakening, the memory of the dream may cause distress to the dreamer as they realise that the action of harming others contradicts their values, personal beliefs, and knowledge about themselves, resulting in a PE. Further, individuals who have experienced traumatic events during wakefulness can re-experience these events in dreams (APA, 2013), potentially inducing further distress upon awakening and perhaps even exacerbating the trauma. Conversely, the trauma-related emotions experienced during the dream might shift to a sense of relief upon awakening if the individual realises that the event was a dream and thus only a construct. It is noteworthy that the concepts proposed in this paper hinge on the assumption that the dreamer recalls their dream experience after awakening, thus enabling its interpretation and PE processing. However, there remains a possibility that dreams that are not recalled may also instigate PE processing and thus have the potential to contribute to trauma. Firstly, while dreams are best remembered when the dreamer wakes directly from



them (Hobson, 2005), it is also possible to remember them if awakening occurs later.<sup>4</sup> Thus, a dream could affect waking cognition even if we do not awaken directly from it. Further, there is the possibility of delayed factual reminiscence, where a dream is recalled much later in the day (Foulkes, 1999). This suggests that dreams that are initially unremembered can be stored in memory to later affect cognition. What about entirely unremembered dreams? While this is a challenging phenomenon to study, it is possible for a dreamer to wake up in a bad mood without recalling the dream that contributed to it. The challenge in studying these dreams, however, lies in their unrecalled nature, making them elusive for analysis. In the following subsections, the interplay between PE and emotional memory with dream experience and waking trauma will be discussed for each of the identified dream types.

#### 4.1 Nightmares

It seems highly plausible that nightmares can contribute to trauma. Nightmares, defined as bad dreams that wake the dreamer (Levin & Nielsen, 2007)<sup>5</sup>, usually awaken the dreamer during late-night rapid eye movement (REM) sleep, and the dreamer has a clear recall of the dream content (Krakow & Zadra, 2006). Unexpected, scary, or distressing events cause intense fear, surprise, and startle that leads to waking. The dream may simulate frightening events such as serious injury, death, or sexual violence. These dreams can negatively impact cognition, mood, and behaviour as well as generate distress and cause functional impairment (Köthe & Pietrowsky, 2001). Even though dreamers may, on waking, rationalise these experiences as ‘just dreams’, they can continue to fear reliving similar experiences when they fall back asleep. Indeed, frightening dream content can occur unexpectedly, thus generating a PE, such as ‘when I fall asleep, I am not as safe and peaceful as I thought’. This shapes the subsequent prediction, such as ‘if I fall asleep, I will be scared again by terrifying dream content’. Individuals who have had nightmares or suffer from nightmare disorder can develop a fear of sleep due to distressing dream experiences. This can result in a night of poor sleep or lead to longer-term insomnia (Krakow, 2006; Lancee & Schrijnemaekers, 2013). Poor sleep can be detrimental to cognition, mood, and behaviour, causing distress. Given the crucial role of sleep in overall health and cognition (Chaput et al., 2020; Gilley, 2022;

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<sup>4</sup> There is some contention as to whether we remember dreams we do not wake up from. It could be argued that even dreams that are reported when waking normally in the morning were interrupted by waking, either because the dream just occurred or because of a micro-awakening earlier in the night. However, in the literature, waking generally is described as greatly *increasing* the chance of remembering a dream, not a *necessary* condition, and other features of dreams affect whether we remember them such as salience (Parke & Horton, 2009) and bizarreness (Foulkes, 1979).

<sup>5</sup> We cannot discern with certainty whether a dream is what caused the individual to wake. Therefore, this criterion usually relies only on the subjective report of the dreamer.

Kudrnáčová & Kudrnáč, 2023), sleep disturbances arising from aversive dreams likely pose a significant threat to the dreamer's well-being.

Dream content can also cause “powerful physical and emotional carry-over” into waking life (Bulkeley et al., 2005, p. 213), impacting mood and behaviour and leading to distress, anxiety, and depression (Blagrove et al., 2004; Levin & Fireman, 2002). Dwelling on the content of the nightmare may impair one's functioning and ability to carry out daily activities. Nightmares are a common symptom of PTSD. In these cases, one may argue that it is unclear whether the dream itself should be considered a separate traumatic event or merely a response to trauma. Importantly, not all nightmares are a response to PTSD — most people at some point in their lives have experienced a nightmare, but not everyone who has nightmares suffers from PTSD. Many nightmares are *idiopathic*, in other words, with no known cause (Neilsen et al., 2011). In idiopathic cases, the nightmares themselves could contribute to trauma independently of previous waking traumatic experience. Further, we cannot straightforwardly dismiss PTSD-related dreams as having separate traumatic effects. One may argue that a person with PTSD experiencing dreams that ‘replay’ the traumatic event could be further traumatised since reactivating a consolidated memory can reinforce the original trauma memory if not updated during the reconsolidation window (Sara, 2000). For example, following a car accident, someone may suffer from nightmares where a boulder is crushing them. The nightmare itself may contribute to trauma, either by worsening the effects of PTSD or causing new separate effects. These can include increased suicide risk and fear of falling asleep (Campbell & Germain, 2016). The latter would be a separate effect if the individual didn't initially fear falling asleep due to the trauma but only became fearful after the nightmare.

#### 4.2 Unpleasant, neutral, and pleasant dreams

Unpleasant dreams are dreams characterised by nightmare-like, distressing, or negatively toned features that do not lead to awakening. Similar to nightmares, we argue that unpleasant dreams may also contribute to trauma and may cause the dreamer to fear falling asleep due to the memory of the unpleasant dream. Just like with nightmares, it is plausible that an unpleasant dream can be surprising, distressing, or terrifying, but unlike nightmares, fails to cause the dreamer to awaken. Further, emotions may carry over into the following day (Mallett et al., 2022; Schredl & Reinhard, 2010) and the dreamer might be distracted by the disturbing content of the dream, disrupting behaviour and cognition, just as is the case with nightmares.

A neutral dream is one with no positive or negative affect valence. Of course, most dreams will contain some neutral features, for example, I may be in a neutral location that evokes no particular emotion. We refer to dreams that, as a whole, evoke no positive or negative

response as neutral dreams. It is unlikely that neutral features will contribute to trauma when a neutral affect is expected in the situation or no PEs occur. However, neutral affects might contribute to trauma if they involve PEs. For example, a dreamer may experience an unexpected absence of emotional response during the dream due to poor binding between features, which is a common occurrence (Revonsuo et al., 2002). Binding is the bringing together of different features to create a cohesive experience, including elements such as colour, shape, texture, emotions, and cognitive features like beliefs (Revonsuo, 1999). Cases of unexpected neutrality may contribute to trauma if the dreamer is disturbed by their lack of affect after waking from an experience they judge should evoke a response. For example, one might find it very disturbing, after waking, having dreamed of one's loved-one's untimely death and experienced no emotional response. One might also find the content of the dream to be disturbing after waking despite the fact that, due to binding failure, the dreamer did not find it disturbing while it occurred.

We consider dreams with hedonic or positive characteristics as *pleasant* dreams. Similar to neutral dreams, pleasant dreams may have unexpectedly pleasant valence due to binding failure. A dreamer may, for example, find themselves feeling unexpected positive emotions such as feeling smug when a sibling fails to achieve something they had hoped for, finding great amusement in something bad happening to a friend, or even feeling joy at the death of a loved one. As with any type of dream, PEs can occur during the dream or after waking. It may be more likely that the dreamer would not experience a PE in such dreams until after waking due to altered cognitive features (Yu & Shen, 2020), causing the dreamer to overlook the unusual response whilst in the dream. If a dreamer does indeed experience poor binding due to altered cognitive capacities, we might expect poor attention to also be a feature, resulting in the mismatch going unnoticed. Such dreams might even involve a disconnection between the dream self and waking self (Rosen & Sutton, 2013). In such cases, a PE occurs only after waking when the memory of the dream conflicts with what the dreamer predicts *should* have happened during such an occurrence.

The dreamer might also have negative effects from PEs due to the contrast between the dream and reality. For example, one of the authors recounts a pleasant dream where she mediated a family dispute between her mother and aunt. Towards the end of the dream, when the difficult situation was successfully addressed, she experienced feelings of relief and reassurance. However, these were replaced by a sense of sadness and distress that persisted for several days after the dream, as her mother and aunt had indeed been engaged in a real-life dispute for several years. On waking she realised that the dream was not a reflection of reality and that she remained uncertain about how to help resolve the conflict. Here, the anticipated positive emotional outcome, characterised by relief and reassurance during the dream, sharply contrasted with the subsequent negative emotions that surfaced upon awakening, this contrast indicating a PE. While one might argue that in this case, it was the waking situation that caused the negative effect, the dream is what incited the PE, leading to intensified sadness





and distress that would not have occurred otherwise. It is also possible for the dreamer to notice and be disturbed by their emotional response during the dream. Lack of attention is not a necessary feature of dreaming, as there are cases of poor binding that the dreamer notices, pre-lucidity being one such case. In such dreams, the dreamer begins to question their reality after noticing something odd (Mallett et al., 2021). Thus, for pleasant or neutral dreams, PEs that contribute to trauma can occur in the dream or after waking when they lead to feelings of guilt, shame, or other kinds of distress.

We might expect that highly unpredicted PEs, as opposed to PEs that are less surprising, could be associated with increased lasting effects on the dreamer. If one expects to feel intense sadness at the death of a loved one, feeling neutral would evoke a PE. However, if feeling joy is even more strongly unexpected, it can potentially evoke a more surprising PE and a heightened sense of unease. In either case, one might grapple with the moral and emotional complexities of feeling neutral or positive about such an event. Such dreams may have the potential to negatively affect relationships. If a dreamer thinks that the content of a dream reveals hidden desires or features about their personality, they could come to question their waking feelings for their loved one, thus contributing to trauma.

### 4.3 Visitation dreams

Visitation dreams are dreams during which one encounters a deceased relative or loved one (Barrett, 1992). These dreams can offer comfort and emotional support to the dreamer (Wray & Price, 2005). They often provide closure through actions like saying goodbye and the opportunity to express love, affection, or forgiveness. For instance, a participant in Bonamino et al. (2023) described an encounter in a lucid visitation dream with a deceased friend, highlighting how this interaction assisted him in coming to terms with his death.

Having that mental relief of erm one last conversation [...] it was to give myself a bit of closure when S. died. [...] And I feel like it just kind of opened my mind up to the possibility that it's like not as much as I'm letting on to be [...] And erm I just felt like, a lot more content with him passing.

Visitation dreams can also evoke a positively valenced PE if the dreamer has an unexpected positive encounter. Conversely, a similar dream experience could evoke painful emotions if the dreamer is not prepared to say goodbye or part from their loved one. A negative visitation dream may also occur if the loved one fails to express affection and instead conveys negative emotions such as hatred: "I had plenty [of] scary dreams of [my grandma] after her death. one of the first ones and scariest ones was when she came back to life and chased me with a knife" (Agile\_Albatross6054, 2023). Such dreams can cause the dreamer to experience a negatively valenced PE. Not expecting to have to say goodbye to their loved one at that stage of their grieving process and failing to anticipate the negative behaviour of the deceased



would evoke PEs. These PEs can occur during the dream or after awakening. One might be surprised to see the deceased loved one or be shocked by their behaviour during the dream. Alternatively, due to the limited access to memory during dreams, they may forget that the loved one has died or fail to find their disturbing behaviour unusual. In such a case, the dreamer may experience a PE about their dream experience only after waking. These types of experiences could potentially lead to lasting emotional distress, which is a key indicator of a response to trauma.

#### 4.4 Lucid dreams

Typically, when we dream, we are not aware of the fact that we are dreaming. At times, however, we come to the realisation that what we are experiencing is a dream. This is known as lucid dreaming (LaBerge, 1985). During lucid dreams, our ability to remember the conditions of our waking life, to deliberately act, reflect, and influence oneiric content is often increased<sup>6</sup> (Noreika et al., 2010; Windt & Metzinger, 2007). Lucid dreaming can result from the occurrence of PEs. An unexpected dream event could trigger surprise and prompt the dreamer to question whether they are awake (pre-lucidity), potentially leading to lucidity. Subsequently, this lucid state could generate additional PEs. For instance, the dreamer might recognize a dangerous situation as a dream, realising it is not as threatening as initially predicted. Due to the ability to update expectations with this newfound understanding of the dreamscape, lucid dreams may offer a way to help individuals suffering from nightmares reduce their frequency and intensity (Ouchene et al., 2023).

It was a nightmare, I was with my father who is a pilot and we were in a jet that was about to crash, and on fire etc. I realized that I was in a dream but couldn't change anything and also could not wake up. It was more or less like watching a movie, knowing it's all fake, but still seems real and well put together. (sleepanddreamdatabase.org, Lucid Dreams 2010 Gackebach:lucid:687 10-30-2010)

Becoming lucid in the aforementioned dream prompts the dreamer to reassess their predictions regarding the consequences of the unfolding dream events. The realisation that they are not in the waking world may result in a resignification of the dream event, with the dreamer understanding, for example, that there is no physical threat. In this context, PEs, rather than contributing to trauma, may serve to alleviate it. Alternatively, dreamers can escape a frightening dream by deliberately waking themselves up, or by manipulating its content to make it more pleasant. For instance, they may create a doorway or portal leading

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<sup>6</sup> In non-lucid dreams, it is also possible to deliberately act, reflect and influence oneiric content (Rosen, 2021b), and conversely, there are instances where one may not be able to do so during lucid dreaming. However, it is far more common to exhibit these abilities during a lucid dream.

into a non-threatening dream environment, thereby providing them a means for a shift to a more positive dream experience.

I remember having a nightmare and in my dream I was running away from someone trying to catch me. I kept running, and running until I reached the end of a cliff. When I realized it was just a horrible dream I knew that if I jumped off that cliff I would be safe and wake up from falling like I always do. I was right. When I jumped off that cliff I opened my eyes instantly, and realized it was just another one of those dreams I was able to control. (sleepanddreamdatabase.org Lucid Dreams 2010 gackebach: lucid:304 10-30-2010)

As this dream report illustrates, dreamers may also recognise nightmare-like or unpleasant facets within their dreams and promptly act to prevent the undesired events from unfolding. This could be achieved in several ways. For instance, one may notice an unexpected ‘creepy’ figure down a dark alley. If the dreamer is lucid, they may choose to ignore the figure’s presence, confront it, or remove themselves from the situation, for instance, by flying away. Thus, if dreams can contribute to trauma through PEs, lucid dreaming could potentially mitigate, at least in part, such trauma contributions by preventing them. Nonetheless, if the nightmare itself is caused by or linked to a previous traumatic event experienced by the dreamer, avoiding its frightening content through lucid dreaming may prevent emotional memory reactivation, and thus its updating through reconsolidation. Since this reactivation is pivotal both for the updating and strengthening of memories (Alberini & LeDoux, 2013), and updating is required to alleviate trauma, avoidance through lucid dreaming may prevent a potential memory updating that could have helped with the alleviation of the original trauma. However, avoiding the nightmare may also impede the memory’s reinforcement, thus not exacerbating the trauma either.

Lucid nightmares are a subset of lucid dreams where dreamers, although aware of being in a dream, are unable to alter the frightening experience through deliberate oneiric manipulation or awakening despite efforts<sup>7</sup> (Stumbrys, 2018). The belief that one is dreaming along with the realisation that they are unable to influence their dream despite their expectations may result in a PE. These dysphoric dreams and the PEs associated with them can involve particularly terrifying experiences for the dreamer, likely contributing to trauma. Bonamino and colleagues (2023) reported an account of a lucid nightmare during which a dreamer was forced to choose which of his parents was to die. Despite his best efforts, he was surprised when he was unable to alter the dream into a more pleasant experience or wake himself up and was thus forced to experience the dream until his alarm eventually woke him. This dream was perceived as particularly unusual and distressing, leaving him in a state of shock upon awakening: “I just remember waking up and I went ‘oooof’ ... cos it was just terrible, tormenting.” Whilst it seems plausible that lucid nightmares can contribute to

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<sup>7</sup> Note that in the literature, “lucid nightmares”, unlike nightmares, do not necessarily wake the dreamer.

trauma, it remains open whether a case can be made for unpleasant dreams that have been successfully overcome or prevented through lucid dreaming contributing to trauma. Consider the earlier example of a dreamer deciding to fly away from the frightening figure who had unexpectedly appeared at the end of a dark alley. While the threat was avoided within the dream, a fear memory may have nonetheless been consolidated. If the consolidation of the fear memory can lead to the aforementioned responses of sleep avoidance and negative effects on one's waking cognition and functioning, the experience can be seen as contributing to trauma. In sum, it is unclear whether successfully avoiding a threat within the dream would necessarily negate any fear of having further nightmares, prevent negative effects on sleep quality, and neutralise all contributions to trauma.

Lucid dreaming shares similarities with waking imagination in that dreamers are not only aware of being in a dream, but they may also be conscious of their actions and deliberately influence oneiric content (Laberge, 1985). On one hand, this sometimes enables individuals to direct their dreams towards more positive experiences, preventing unpleasant and nightmare-like dreams from unfolding. On the other hand, it also grants dreamers the freedom to engage in desired activities without the repercussions they would normally face if they were awake (Bonamino et al., 2023). This free rein to act in a consequence-free environment raises ethical considerations and may potentially cause lucid dreams to contribute to trauma. This risk arises when the consciously directed actions within the dream conflict with the dreamer's personal ethics and beliefs. The dreamer may recognize this discrepancy during the dream itself or after awakening, causing a PE to occur.

The following is an account of a lucid dream experienced by a participant in an ongoing project led by one of the authors. This participant is in a de-facto relationship with her partner M. In her lucid dream, she intentionally engaged in sexual intercourse with J., a friend from her waking life.

I pinched my nose and realised I could breathe through it. That's when I knew I was in a dream. I saw this figure by my bedroom window and realised that it was J. Before I knew it, we were having sex. I was well aware of what I was doing, and that it was J., and not M. I didn't feel guilty though, in fact, I was enjoying it and I didn't want it to stop.<sup>8</sup>

Upon awakening, the excitement and pleasure experienced during the dream were replaced by feelings of guilt and distress. The dreamer hadn't expected to feel enjoyment while engaging in those actions, resulting in a PE. Throughout the day, she found herself repeatedly distracted from her work, ruminating about her dream. She felt guilty for potentially breaking her partner's trust and was confused about her feelings for J. and whether she was morally obligated to share her dream with her partner. We consider such effects as a

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<sup>8</sup> Consent for inclusion of this dream report was obtained from the participant.

type of trauma contribution if, like the effects of waking trauma, they have continuing negative effects on the individual's waking behaviour, cognition, and emotional wellbeing. The trauma contribution of this dream was likely enhanced as it wasn't the first time she had dreamt of engaging in sexual activity with J.

## 5. Dreams and trauma alleviation

Regardless of whether dreams played a role in its manifestation, trauma is inherently multifactorial. One could argue that the treatment of trauma related to dreams could require the same or similar approaches applied to any form of trauma, including current methods used for PTSD and nightmares. Various therapeutic approaches can lead to the reconsolidation of emotional memories (Ecker et al., 2012). Although this paper focuses on the specific contributions of dreaming to trauma and trauma alleviation, in the following we briefly note some of the methods currently used to assist with nightmare treatment and include recommendations for future research. Then, we shift focus to the use of dreams themselves as a method of alleviating trauma.

### 5.1 Treatments to alleviate the trauma effects of dream-related PEs

If dreams do indeed contribute to trauma through PEs, as argued, it is important to consider how these effects could be mitigated. There is supporting evidence that lucid dreaming therapy may reduce nightmare frequency and intensity (Ouchene et al., 2023). We have previously noted how lucidity and control might help reduce or avoid the PEs related to trauma contributions. Further, lucid dreaming can promote positive waking moods (Stocks et al., 2020). Therefore, lucid dreaming might be beneficial not only for alleviating nightmares but also for the negative cognitive and emotional effects arising from the other dream types discussed in this paper. However, lucidity is difficult to achieve, and to date, there is not one method that can reliably induce lucid dreaming (Stumbrys et al., 2012; Tan & Fan, 2022). Other promising treatments for nightmares disorder (for a review see Giesermann et al., 2019; Spangler & Sim, 2023) include pharmacological therapy (Nadorff et al., 2014), Imagery Rehearsal Therapy (Neidhardt et al., 1992), exposure, relaxation, and rescripting therapy (Davis, 2009), and nightmare deconstruction and processing (Spangler & West, 2018).

The potential for pleasant and neutral dreams to contribute to trauma is a novel discussion here, and currently, there is no empirical research on methods to mitigate such contributions. Given the trauma-contributing potential of these dreams, further research on these contributions and effective mitigation strategies is recommended. As previously argued, several factors can affect whether one's experience in a dream will contribute to trauma. Thus,

it would be valuable to investigate how individual differences may lead to some being more negatively affected by their dreams. Feelings of guilt, shame, or questioning of one's relationships following PEs after waking from neutral or pleasant dreams may relate to the personal importance or meaning individuals ascribe to dreams. Understanding people's attitudes and beliefs towards dreams and their potential effect in relation to trauma may also be beneficial for devising mitigation strategies. For example, individuals who perceive dreams as holding hidden meanings may be more susceptible to dreams impacting their lives negatively compared to those who consider them of random or non-significant nature. If this is the case, there may be potential to help those negatively affected by re-emphasising that dreaming isn't necessarily a 'window to the soul' and that we are often not in control of them. Alternatively, research may reveal that those who assign little meaning to dreams can be equally negatively affected, in which case, such therapies would have limited efficacy. Regardless of the findings, it would be of value to gain more insight through empirical investigation about the relationship between individual differences, dreaming, and trauma.

## 5.2 The use of dreams in psychotherapy to alleviate trauma

Dreams can be used in psychotherapy to identify and reactivate emotional memories, including traumatic ones, and to update these memories through reconsolidation (Boudrias, 2024). The following example illustrates this therapeutic process. A client in psychotherapy related a painful event that left enduring traces on her subsequent functioning. Years before undergoing psychotherapy, she had returned from a self-development retreat with high hopes of reconnecting with her partner, the father of her children (prediction). Upon arriving home, her partner informed her that he was leaving her for another woman. This painful event was highly unexpected (PE), and years later, she still couldn't tolerate hearing about him and tried to not think about him to avoid the painful emotions associated with this memory. Even her daughter could not speak about her father in her presence. During a dream-based art therapy session, she worked on the following dream, which seemed to reflect her former traumatising PE, enabling the reactivation and updating of her emotional memory:

I am in an unknown place, stopped during a road trip [...] I look for my purse while searching those of other women left on the ground in a corner. I tell myself that by looking in the bags, I will find objects that belong to me [...] My ex-partner changed our car without telling me or asking my opinion! He left without me, abandoned me!<sup>9</sup> (Translated from French)<sup>10</sup>

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<sup>9</sup> Consent for inclusion of this dream report was obtained from the participant.

<sup>10</sup> This quote belongs to a patient who participated in the Project 2021-06 "Faciliter le processus



In the art therapy session, the client noticed that she attempted to make him uglier and even to make him disappear symbolically in the drawing of her dream. However, upon reflection, she realised that this act of symbolic avoidance and revenge did not bring the expected feeling of relief (prediction: 'avoidance and revenge will result in relief'), generating the PE 'avoidance and revenge do not relieve me, but rather generate guilt'. As illustrated by this example, PEs can impact subsequent decisions and actions (Heffner et al., 2021). At the follow-up session, the client exhibited increased empathy towards her ex-partner and admitted she could engage in more open discussions with her daughter. This example shows how a dream can be used in psychotherapy to reactivate a trauma-related memory and how in session, PEs can be used to update it. However, whether a dream alone, without therapeutic intervention, is sufficient to update such memories remains an open question. Evidence from visitation dreams, as previously discussed, suggests that individuals can indeed feel closure that can help overcome trauma in certain contexts. In the case above, however, the dream-based therapy session likely is what contributed to achieving psychological improvement.

If dreams, as we propose, can both contribute to and alleviate trauma, addressing them while focusing on related PEs within therapy may be a valuable approach, especially when the dreamer's reactions to their dreams are also considered. If emotional memories can be reactivated through dreams via PE processing occurring during dreams or in reaction to them after awakening, dreams may be considered valuable material for updating emotional memories through reconsolidation in psychotherapy (Boudrias, 2024; Ellis, 2019). However, although psychoanalysts use dreams in therapy more frequently than humanistic and cognitive-behavioural therapists (Schredl et al., 2000), many therapists are hesitant to incorporate dream material into their work with their clients, partly due to a lack of training and a perceived lack of competence in this area (Leonard & Dawson, 2018). Despite the numerous therapeutic benefits observed when working with dreams (for a review, see Eudell-Simmons & Hilsenroth, 2005; Spangler & Sim, 2023), one could argue that working with other material or different kinds of mental states, such as episodic memories, may have similar therapeutic effects. Nonetheless, some evidence suggests greater efficacy in using dreams in therapy instead of episodic memories. For example, Edwards and colleagues (2015) tested two dreamwork methods, the "Appreciating dreams" method of Ullman (1996) and the "Listening to the dreamer" method of Schredl (2011). These were compared to a 'control condition' in which participants used the same method with a report of a recent event instead of a dream. Both methods showed a higher level of insight for the participants who worked with a dream compared to those who worked with a recent waking life event, although Schredl's method slightly failed statistical significance. While promising, further research is

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thérapeutique de reconsolidation des mémoires émotionnelles par la représentation visuelle du rêve" de l'Université du Québec en Abitibi-Témiscamingue, approved by the ethics committee CER-UQAT.

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needed to support the claim that dream work is more effective than working with other material and if so, under which conditions.

## 6. Conclusion

While dreams are often viewed as a response to trauma, the relationship between dreaming and trauma is complex. Dreams can be analysed in reference to PEs that occur during dreams or after waking and may have the potential to either contribute to or alleviate trauma. What makes a dream trauma-contributing or trauma-alleviating involves a broad set of features and contexts. Nightmares are a plausible example of dreams that can contribute to trauma, either by exacerbating a trauma response to a previous experience or by acting as a traumatic event in themselves. We have argued that unpleasant dreams could contribute to trauma in ways similar to nightmares. Even neutral and pleasant dreams, perhaps counterintuitively, could have this effect through PEs and moral assessment of the dream by the dreamer. Such experiences could negatively affect the emotional, cognitive, and personal life of the dreamer. Lucid dreaming may contribute to trauma in similar ways despite the fact that we know we are dreaming, however, it may also offer a potential avenue for preventing the trauma contribution of dreaming through dream manipulation. Dreams can also help alleviate responses to waking trauma. We have theorised that the experience of a dream itself may be beneficial, an example being visitation dreams that can provide comfort to those who have lost a loved one. Finally, clinical evidence suggests that working with one's own dreams, with attention paid to PEs, can help further alleviate trauma. Due to the potential of dream research as a way of understanding trauma and helping those who suffer from it, further philosophical investigation and empirical study should be devoted to analysing the relationship between dreaming and trauma.

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