Imagery rescripting of emotional memories
Kunze, A.E.

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General introduction
Emotional memory

The first day of school. The birth of a child. The death of a loved one. Emotional memories are the core around which we build our personal stories. From an evolutionary perspective, the ability to remember emotional events more strongly and vividly than neutral ones may serve a vital function: Emotions often signify information that is crucial for survival and reproduction (Hamann, 2001). However, when enhanced memory for emotional stimuli fails to facilitate adaptive responding to future situations - as is evident in emotional disorders - emotional memories can become dysfunctional and even harmful (Hackmann & Holmes, 2004; Holmes & Mathews, 2010; Holmes & Hackmann, 2004).

Maladaptive emotional memories often take the form of mental images, which access sensory information from memory rather than from actual perception (Kosslyn, Ganis, & Thompson, 2001). In recollecting past events, visual mental images can amplify emotions by acting as a substitute for real perceptual information (Holmes, Geddes, Colom, & Goodwin, 2008; Kosslyn, 2005). The centrality of negative imagery in emotional disorders has been broadly acknowledged and treatment techniques aimed at modifying aversive mental images play a key role in clinical interventions (Hackmann, Bennett-Levy, & Holmes, 2011). One such technique is Imagery Rescripting (IR), a transdiagnostic psychological treatment firmly established in cognitive-behavioral therapy (CBT) that specifically focuses on the treatment of distressing emotional memories (e.g., Holmes, Arntz, & Smucker, 2007). Although IR has been shown to be an effective treatment for a variety of emotional disorders (Morina, Lancee, & Arntz, 2017), its underlying working mechanisms remain largely unknown. The present thesis aimed to gain insight into the mechanisms underlying the therapeutic process of IR.

Mental imagery in emotional disorders

In emotional disorders, negative emotional memories are particularly prone to being triggered by a multitude of external and internal cues (e.g., Ehlers & Clark, 2000). This often results in the (involuntary) activation of emotional events in the form of intrusive mental images including flashbacks or nightmares. Such symptomatic mental images play a decisive role in the maintenance of many emotional disorders ranging from trauma-related and anxiety disorders to depression and schizophrenia (for reviews, see Hagenaars & Holmes, 2012; Holmes & Mathews, 2010). Although the impact of mental imagery on emotion has long been acknowledged, it was only recently shown experimentally that visual processing of information elicits stronger emotional responses than verbal processing (Holmes & Mathews, 2005; Holmes, Mathews, Mackintosh, & Dalgleish, 2008). Likewise, Arntz and colleagues (2005) found emotion to promote the superiority of perceptual memory compared to conceptual memory, a misbalance in memory systems that is fundamental...
to the processing of traumatic events (e.g., Brewin, 2001, 2006; Brewin, Gregory, Lipton, & Burgess, 2010; Ehlers & Clark, 2000; Roediger, 1990). The question however is: Why does mental imagery have such a potent impact on emotion?

Mental imagery has been shown to activate many of the brain’s systems involved in perception and emotional information processing. For example, mental imagery and externally triggered visual representations employ common sets of neural structures (for a review, see Holmes & Mathews, 2010) and mental images seem to operate like weak versions of real perceptual representations (Pearson, Naselaris, Holmes, & Kosslyn, 2015). In the clinical context, the impact of mental imagery on emotion and behavioral responses becomes particularly evident in the case of intrusive mental imagery such as flashbacks, which comprise a multitude of sensory-perceptual details and information. Individuals experiencing flashbacks typically report that they seem very real, almost as if the traumatic event were happening again in the here-and-now. This often elicits high levels of subjectively experienced distress, bodily symptoms, and even action tendencies similar to those observed during the traumatic event itself (e.g., hiding under the table when hearing a noise that resembled a gunshot).

In sum, the shared characteristics between mental imagery and perceptual processing may offer an explanation as to why basic emotional systems are responsive to the type of signals generated by mental images, and why emotional images can sometimes be responded to as if they were real (Holmes & Mathews, 2010). Imagery may act as an “emotional amplifier” in many emotional disorders (Holmes, Geddes, Colom, & Goodwin, 2008).

**IR in the treatment of emotional disorders**

Given the power of mental imagery on emotions, various therapeutic approaches have embraced imagery as a primary component of therapy and integrated the manipulation of mental images into psychological treatment packages (Edwards, 2007; Hackmann et al., 2011; Holmes & Mathews, 2010). Such treatments aim to reduce the impact of dysfunctional imagery on emotion and the frequency of intrusive mental imagery (Pearson et al., 2015). For example, evidence-based techniques such as imaginal exposure (IE) have long been integrated in CBT. During prolonged IE, patients are confronted with a feared stimulus or situation in their imagination until the associated distress and bodily symptoms gradually decline. More recently, imagery rescripting (IR) was introduced as a means to change emotional memories (e.g., Arntz & Weertman, 1999; Holmes et al., 2007; Smucker, Dancu, Foa, & Niedere, 1995; for an overview of various forms of imagery with rescripting, see Edwards, 2007).

With IR, emotion-inducing images that contribute to the onset and maintenance of emotional disorders are actively modified in order to reduce negative emotions and other
associated psychological symptoms. In therapy, patients are first instructed to imagine the memory (or mental image) as vividly as possible. Next, they are asked to change the sequence of events into a more desired direction (for a case example, see Box 1), or to introduce trustworthy helpers (e.g., the therapist) to the imagined situation, who can assist patients to construct a new, more benign image.

Box 1. Case example: Imagery re-scripting of recurrent nightmares

Melanie K. is a 29-year-old patient with recurrent nightmares. At least two nights per week, Melanie awakens from her nightmares in fear. She usually has the same dream, which involves Melanie being accused of murder. In her nightmare, Melanie is sentenced to death for a crime she did not commit. She is tied to a disproportionally large chair, while her family stands around her watching the scene indifferently. Melanie screams and begs her father to help her, but he does not seem to notice her pleas. With increased fear, Melanie notices an execution officer entering the room, who starts moving towards her. Melanie starts to panic and moves wildly in her chair. Tears stream down her face while she is screaming from the top of her lungs: “Dad, help me! I didn’t do it!” Just when the execution officer reaches her, she wakes up. In her bed, she is screaming and shivering. Her heart is pounding high up in her chest as she turns on the lights in her bedroom. It is 4:30 a.m. and Melanie knows that she won’t be able to go back to sleep…

In therapy, Melanie is asked to change the storyline of the nightmare into a more benign image and desirable direction. Melanie closes her eyes and briefly relives the nightmare in her imagination as vividly as possible, right up to the point where she asks her father to help her. Next, the therapist freezes the image and asks Melanie what she needs right now. Melanie explains that she needs her father to respond to her pleas, to acknowledge that she is innocent, and to help her out of the situation. The therapist then asks Melanie to experience this new storyline as vividly as possible and to focus on perceptual details while telling the therapists exactly what happens in the scene: “I scream for help and my father looks at me. Suddenly, his eyes widen and he snaps out of what seems like a state of trance. He hastily walks towards me and kneels down next to me. Tears stream down my face and I feel very relieved that he finally heard me. I get angry with him because he did not help me earlier, but he apologizes. He tells me that he didn’t realize the severity of the situation before and that he knows that I am innocent. At the same time, he loosens the bonds that chain me to the large chair. My arms and legs feel sore from the bonds, but my father finally helps me to get out of the chair. He lifts me up and runs past the execution officer who stands in the middle of the room and doesn’t understand what is happening. We reach the door and slip through it. After closing the door behind us, everything is quiet. I don’t know where we are, but we are alone and the sun is shining brightly. My dad puts me down on my feet, but keeps supporting me so that I won’t fall. My legs are still shivering, but I soon regain strength and look up to my dad. He looks at me and I see pain and sorrow in his eyes. He says that he is sorry that I had to go through this and that he didn’t help me earlier. He tells me that I am his little angel and he promises me that he will never let anything bad happening to me ever again. From the way he looks at me, I know that he is sincere and that I can believe him. I feel so relieved and so happy that my dad finally helped me. We hug very intensely. The sun feels nice and warm on our arms and backs. After some time, we let go of each other and we both smile.”
Compared to traditional and primarily verbally-based cognitive treatment techniques that focus on patients’ thoughts and interpretations of events, IR uses the patients’ experienced emotions and responses after memory reactivation as a starting point for therapy. Thus, in line with the importance of perceptual processing in emotional memory as outlined above, IR uses perceptual means rather than verbal modes to target emotional memories (Arntz, Tiesema, & Kindt, 2007). For that reason, IR was recently integrated into several treatment packages for a variety of disorders of emotional memory, such as CBT-based treatments for simple phobias (e.g., Hunt & Fenton, 2007), PTSD (e.g., Arntz & Weertman, 1999; Ehlers, Clark, Hackmann, McManus, & Fennell, 2005; Grunert, Smucker, Weis, & Rusch, 2003; Rusch, Grunert, Mendelsohn, & Smucker, 2000; Smucker et al., 1995), social phobia (e.g., Clark et al., 2006; Frets, Kevenaar, & van der Heiden, 2014; Lee & Kwon, 2013; Nilsson, Lundh, & Viborg, 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild & Clark, 2011; Wild, Hackmann, & Clark, 2008), nightmares (e.g., Davis & Wright, 2006; Krakow & Zadra, 2010; Long, Hammons, et al., 2011), depression (e.g., Brewin et al., 2009; Wheatley et al., 2007), and personality disorders (e.g., Arntz & van Genderen, 2009; Giesen-Bloo et al., 2006; Weertman & Arntz, 2007). Hence, IR constitutes a transdiagnostic treatment method with the potential of a wide application. Systematic reviews (Arntz, 2012) and meta-analyses (Morina et al., 2017) support the efficacy of IR in several psychological disorders such as PTSD, social anxiety disorder, body dysmorphic disorder, bulimia nervosa, depression, and OCD. In addition, IR was found to produce beneficial effects in the treatment of nightmares (Augedal, Hansen, Kronhaug, Harvey, & Pallesen, 2013; Hansen, Höfling, Kröner-Borowik, Stangier, & Steil, 2013; Lancee, Spoormaker, Krakow, & van den Bout, 2008) and preliminary evidence supports the efficacy of IR as one of the primary components of schema therapy in personality disorders (Jacob & Arntz, 2013).

Remarkably, IR seems to produce effects similar in magnitude as those observed with more traditional exposure-based treatments (Hansen et al., 2013; Kunze, Arntz, Morina, Kindt, & Lancee, 2017; Øktedalen, Hoffart, & Langkaas, 2015), though adequately powered comparisons of stand-alone exposure versus rescripting treatments are currently lacking. Furthermore, IR may bring about broader change than exposure (Arntz et al., 2007). For example, IR may be more effective than exposure in disorders that do not exclusively involve fear-eliciting emotional images but also other emotions and cognitions such as guilt or shame (e.g., in PTSD). Indeed it was shown that shame and guilt as primary emotions are associated with reduced efficacy of exposure (Grunert et al., 2003; Grunert, Weis, Smucker, & Christianson, 2007) and that a combination of IE and IR reduced guilt more effectively than IE alone (Arntz et al., 2007; but see Øktedalen et al., 2015). In addition, IR appears to be less distressing for patients (Arntz et al., 2007; Kunze et al., 2017) and therapists when compared to exposure. This may lead to reduced drop-out rates and increased treatment adherence in IR.
In sum, IR appears to be an effective transdiagnostic psychological treatment method, which may even have advantages over evidence-based exposure treatments. Yet, systematic research on the underlying processes of the technique has only just begun.

**Underlying working mechanisms of IR**

It is generally agreed that IR aims to manipulate the emotional memories underlying affective disorders. Modern learning theory (e.g., Davey, 1997; Mineka & Zinbarg, 2006) offers a theoretical framework to explicate the memory processes involved in IR. Within this model, it is assumed that a conditioned stimulus (CS) does not directly evoke a conditioned response (CR). Instead, the CS triggers a mental (cognitive) representation of an aversive event (unconditioned stimulus; UCS), and this memory trace (or the expectation that the UCS might occur again) then leads to the CR (see Figure 1.1). The intensity of the CR is determined by two factors: First, the strength of the association between CS and UCS (i.e., outcome expectancy) and second, the evaluation of the UCS memory. Based on this theory, two hypotheses about how IR may specifically modify emotional memories can be derived.

On the one hand, it has been suggested that IR facilitates the formation of an alternative memory trace that competes with the original fear memory at retrieval (e.g., Çili, Pettit, & Stopa, 2017; Holmes & Mathews, 2010). According to the retrieval competition theory (Brewin, 2006; Brewin et al., 2010), psychological therapies such as IR facilitate the generation (or strengthening) of new or alternative, positively valenced memory representations (CS-noUCS association) that compete with the old and problematic, negatively valenced memories (CS-UCS association) when presented with the same retrieval cues at any given moment. In line with this view, it could be argued that IR manipulates the contiguity (i.e., outcome expectancy) of the original CS-UCS association, which deactivates the original UCS memory. This mechanism is also observed in exposure treatments, where a new, inhibitory memory is formed (Bouton, 2002, 2004; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Vervliet, Craske, & Hermans, 2013).

On the other hand, it has been put forward that IR directly changes the meaning of the memory representation of an aversive event, possibly through UCS-revaluation processes (e.g., Arntz, 2011, 2012; Arntz & Weertman, 1999; Dibbets & Arntz, 2016; Dibbets, Poort, & Arntz, 2012; Hagenaars & Arntz, 2012; Morina et al., 2017). Davey (1997) emphasizes that the strength of a CR can be manipulated irrespective of any changes in the contiguity of the CS-UCS association. Instead, the CR can be modified by factors that change the evaluation of the UCS. For example, additional information about the UCS can lead to decreases of the CR (if the information devalued the original UCS) or increases of the CR (if the information further inflated the negative valence UCS). Thus, in contrast to processes that tap into the evaluation of CS-UCS contingencies, UCS-revaluation offers a means to reduce the CR by changing the evaluation of the UCS in the original representation of the CS-UCS association.
directly. Within this process, IR can be viewed as a method to generate additional, corrective information about the UCS that is included into the mental representation of the existing memory, thereby changing its dysfunctional meaning (i.e., UCS-devaluation). Though UCS-devaluation theory does not explicitly preclude the development of inhibitory CS-UCS associations, we refer to UCS-devaluation as a means to directly change the meaning of the UCS-memory representation of the original CS-UCS association for the remainder of this thesis.

Even though it has long been thought that emotional memories cannot be changed directly, it was recently shown that such memories could be modified when they are in an instable and malleable state after retrieval (Kindt, Soeter, & Vervliet, 2009; Nader, Schafe, & LeDoux, 2000). The phenomenon is known as the process of memory reconsolidation and refers to a time-limited destabilization of a consolidated memory trace. When the reconsolidation process of a memory is manipulated, the behavioral and subjective responding to the memory can be altered (for a review, see Beckers & Kindt, 2017; Elsey & Kindt, 2017). Reconsolidation of emotional memories can be disrupted by pharmacological manipulations (e.g., Dębiec & LeDoux, 2004; Kindt et al., 2009; Nader et al., 2000; Sevenster, Beckers, & Kindt, 2013) and behavioral interventions (e.g., Golkar, Tjaden, & Kindt, 2017; James et al., 2015; Monfils, Cowansage, Klann, & LeDoux, 2009; Schiller et al., 2010), but see Beckers and Kindt (2017) for a review of mixed findings regarding the disruption of reconsolidation by means of behavioral interventions. In line with the proposition that memories can be updated when corrective information is presented during their reconsolidation (Lee, 2009), it seems plausible that IR may be a behavioral means to achieve such memory updating.

If it turns out that IR directly modifies the memory representation of the UCS, it may have a major advantage over traditional exposure-based treatments. Even though exposure-based CBT is one of the most effective therapies to reduce the symptomatology associated with dysfunctional emotional memories in trauma- and anxiety-related disorders to date (Hofmann & Smits, 2008; Norton & Price, 2007), relapse is often observed after successful
treatment (Durham, Higgins, Chambers, Swan, & Dow, 2012; Hofmann & Smits, 2008; Loerinc et al., 2015). The return of fear can be explained by the fact that the original memory representation remains intact and competes with the new memory trace formed during treatment. Thus, both memories may be activated depending on their strength and on other determinants. Typical conditions that can trigger the return of fear are changes of external or internal contexts (i.e., renewal), reencounters with the aversive event (i.e., reinstatement), or the mere passage of time (i.e., spontaneous recovery; Bouton, 2002; Vervliet et al., 2013). The return of fear could be prevented on the long-term if the UCS memory representation itself is directly changed. In other words, if IR works via UCS-revaluation, its treatment effects should generalize over multiple internal and external contexts and stimuli, rendering the therapeutic outcomes more sustainable than those induced by exposure treatments.

**Aim and outline of the present thesis**

The current thesis aims to unravel and understand the working mechanisms of IR. For this purpose, the effects of IR are examined in artificially induced and clinically persistent emotional memories.

First, a series of experiments that sought to investigate the effects of IR on induced emotional memories in a laboratory setting are presented. Memory processes underlying exposure treatments are investigated by means of Pavlovian fear-conditioning paradigms, which induce relatively simple associative memories (e.g., pairing the picture of a face with an electric shock). While these paradigms provide invaluable experimental models for the learning and unlearning of simple fear memories, emotional memories usually refer to much more complex fear networks, involving subjective interpretations, attributions, and beliefs next to the associative relationship of the stimuli. Given that IR mainly aims to modify such subjective interpretations and beliefs, chapter 2 presents an adapted fear-conditioning procedure that was specifically developed to model more complex emotional memories in an experimental setting. The new fear-conditioning procedure was then employed in three experiments (presented in chapter 3) to test the prevailing theories about the working mechanisms underlying IR.

Next, in order to advance our general understanding of IR, a randomized wait-list controlled trial that focused on mediators of change in a clinical population is described. As mentioned above, IR has been successfully integrated in CBT-based treatment protocols for nightmare disorder. These protocols typically exist of a multitude of therapeutic elements (e.g., IR and/or IE, nightmare diaries, relaxation exercises, and psycho-education about sleep and nightmares). In order to investigate the working mechanisms of merely IR, we reduced the treatment to a stripped-down protocol that only consisted of IR. Moreover, we also developed a stripped-down IE treatment, which facilitated the previously instigated investigation of the working mechanisms underlying rescripting- versus exposure-based
therapies. Chapter 4 presents the study protocol of a randomized controlled trial aimed (a) to examine the therapeutic efficacy of stripped-down, stand-alone IR and IE and (b) to explore their constituent working mechanisms. In chapter 5, the effects of IR and IE are evaluated compared to a wait-list control group, and chapter 6 examines several proposed mediators of the treatment effects.

Finally, in chapter 7, the main findings of the studies presented in this thesis are summarized and discussed, their implications are considered, and recommendations for future research are outlined.