Imagery Rescripting of Distressing Memories:

Experimental Studies on Effects and Working Mechanisms

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Author Contributions

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Study I: Siegesleitner, M., Strohm, M., Wittekind, C. E., Ehring, T., & Kunze, A. E. (2019). Effects of imagery rescripting on consolidated memories of an aversive film. *Journal of Behavioral Therapy and Experimental Psychiatry, 62,* 22-29. https://doi.org/10.1016/j.jbtep.2018.08.007

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Abstract

Re-experiencing distressing memories of traumatic events in the form of involuntary mental images can often be observed in patients suffering from posttraumatic stress disorder (PTSD). Imagery rescripting (ImRs) is a psychological treatment method that aims to reduce emotional distress by directly targeting these aversive mental images. After reactivation of the traumatic memory, the distressing mental images are changed in imagination into more benign ones, thereby reducing negative emotions, distress, and intrusive re-experiencing. ImRs has been proven to be an effective treatment for distressing memories in PTSD and other emotional disorders. Furthermore, it seems to have several advantages over state-of-the-art exposure-based therapies. However, it still remains unclear how ImRs works. Whereas exposure-based treatments have been shown to work through inhibitory learning (i.e., formation of a new memory that competes for retrieval with the original memory), it has been proposed that ImRs may work through memory revaluation, i.e., changing the meaning of the original memory. Based on this proposition, it has also been discussed whether facilitating feelings of mastery and/or self-efficacy during ImRs may constitute a means to change the meaning of the original memory. Additionally, research into potential working mechanisms of ImRs has just recently begun. In order to investigate treatment effects and working mechanisms of ImRs for distressing memories, the present thesis presents three experimental analogue studies in healthy samples under highly controlled and standardized conditions using the trauma film paradigm (TFP).

Whereas previous studies on ImRs mainly focused on the preventive effects of ImRs on memory consolidation by conducting the intervention shortly after memory induction, **Studies I** and **II** of this thesis examined the therapeutic effects of ImRs on consolidated memories by using a multiple-day TFP. **Study I** investigated the therapeutic effects of ImRs on intrusion frequency and emotional responding when compared to an exposure-based intervention (IRE) and a no-intervention control condition (NIC). Participants (N = 88) were randomly allocated to one of the three conditions and received the intervention 24 h after memory induction, thereby allowing for memory consolidation prior to treatment. Results showed that ImRs was associated with less distress and negative emotional responding when compared to IRE, thereby supporting the assumption that ImRs might be a promising treatment alternative to exposure-based therapies. Although ImRs accelerated the decline of intrusive memories in **Study I**, artificially induced memories appeared to naturally decline quickly after one day, thus limiting the interpretability of the latter finding. Even though the multiple-day TFP was assumed to tap into memory updating processes, **Study I** was not able to specifically test the hypothesis that

ImRs may work through memory revaluation. Thus, in order to allow for a further investigation of memory reconsolidation processes, **Study II** aimed to improve the multiple-day TFP by combining it with a fear-learning procedure and by assessing more objective (i.e., psychophysiological) measures. Participants (N = 115) received either ImRs, IRE, or NIC one day after memory induction. As relapse can often be observed in exposure therapy, possibly due to a reactivation of the original memory, memory revaluation vs. retrieval competition were investigated by assessing a return of fear 24 h after the intervention. Contrary to hypotheses, return of fear on physiological meaures could not be detected in any of the conditions. Thus, no definite conclusions could be drawn from **Study II** about the memory mechanisms which may underlie ImRs. Procedural limitations might have accounted for the unexpected results.

Study III investigated the efficacy of two different ImRs approaches, namely active vs. passive ImRs, as well as mastery and self-efficacy as potential working mechanisms. The two ImRs approaches differed with respect to the role the participants played in the newly developed script. Participants (N = 100) were randomly assigned to active ImRs, passive ImRs, IRE, or NIC shortly after memory induction through an aversive film. Even though previous findings on the preventive effects of ImRs on intrusive memory development could not be replicated in **Study III**, results revealed a non-significant trend that active ImRs might accelerate the decrease of experimentally induced intrusive memories. In line with findings from **Study I**, both ImRs versions were experienced as less distressing when compared to IRE, with passive ImRs being even less distressing than active ImRs. This supports the idea that ImRs might be a more tolerable treatment alternative to exposure-based interventions. Both ImRs interventions increased feelings of mastery, but did not increase self-efficacy, which is more related to the concept of one's self and therefore possibly less prone to modifications by a brief intervention.

By using advanced experimental paradigms for the induction of analogue posttraumatic reactions in healthy samples, the present thesis provides preliminary findings on the therapeutic effects of ImRs on consolidated memories. Additionally, by systematically investigating different ImRs approaches, the current thesis contributes to a better understanding of how different ImRs protocols work and to the processes that may cause therapeutic change in ImRs. Although the analogue paradigms appear to be promising for the investigation of processes involved in ImRs, the suitability of the paradigms to model the effects of ImRs on treatment outcome was impeded by several procedural limitations. Potentials and limitations of the experimental investigation of ImRs in analogue studies are discussed and implications and directions for future research are outlined.

Table of Contents

General Introduction

Distressing Memories in Emotional Disorders

Memories of past emotional events, whether positive or negative, are a part of our everyday experience. When compared to neutral events without a strong emotional component, emotional events are often remembered more vividly and accurately (Reisberg & Hertel, 2003). Given that emotions facilitate adaptive responses to environmental challenges (Keltner & Gross, 1999), the activation of emotions by recalling past emotional events is usually functional. However, after experiencing traumatic events, vivid emotional memories can become highly distressing and dysfunctional (Hackman & Holmes, 2004; Holmes & Mathews, 2010).

In emotional disorders such as posttraumatic stress disorders (PTSD), these distressing memories are often experienced in the form of intrusive mental images (Hackman & Holmes, 2004). Mental images are defined as "seeing with the mind's eye or hearing with the mind's ear" (Kosslyn, Ganis, & Thompson, 2001, p. 635) and can involve all sensory modalities, bodily sensations, and emotions (Holmes & Mathews, 2010). In PTSD, intrusive re-experiencing constitutes one of the hallmark symptoms (American Psychiatric Association, 2013). Given that involuntary, intrusive mental images often derive from previously experienced traumatic events, trauma-associated cues can easily trigger these intrusive mental images (e.g., Ehlers & Clark, 2000). Assuming that mental imagery may act as an emotional amplifier (Holmes, Geddes, Colom, & Goodwin, 2008), aversive mental images can evoke such strong emotional responses, as if the traumatic events were recurring (Dadds, Bovbjerg, Redd, & Cutmore, 1997). Experiencing such extremely negative emotions can block the attention for other information (e.g., knowledge that there is no actual threat) and result in dysfunctional behavior such as avoidance (Holmes & Mathews, 2010; Pearson, Naselaris, Holmes, & Kosslyn, 2015).

Given the power of mental imagery on emotions, imagery-based techniques may also be used in therapy in order to alleviate negative affect, facilitate positive emotions, and change behavior, e.g., by modifying dysfunctional mental images or by implementing positive mental images (Holmes & Mathews, 2010). Clinical interventions that directly target distressing mental images in PTSD and other emotional disorders have gained growing interest in recent years and various therapeutic approaches have integrated imagery as a primary component of therapy (Edwards, 2007; Hackmann, Bennett-Levy, & Holmes, 2011; Holmes & Mathews, 2010). These therapeutic approaches aim at reducing intrusive re-experiencing and the impact of distressing mental images on emotions (e.g., Pearson et al., 2015). One such imagery-based technique is imagery rescripting (ImRs), a transdiagnostic treatment approach that aims to directly modify dysfunctional mental images (e.g., Arntz, 2012; Holmes, Arntz, & Smucker,

2007). Although ImRs is a promising technique (for a meta-analysis, see Morina, Lancess, & Arntz, 2017), research into its effects and underlying working mechanisms is still in its infancy. Therefore, the present thesis aims at improving our understanding of ImRs as a treatment for distressing memories.

Imagery Rescripting in the Treatment of Emotional Memories

ImRs is an imagery-based treatment approach that has originally been developed for the treatment of early childhood trauma (Arntz & Weertman, 1999; Smucker, Dancu, Foa, & Niederee, 1995). Over the past decades, it has been integrated in CBT approaches not only for PTSD (e.g., Arntz, Tiesema, & Kindt, 2007; Hackmann, 2011; Long & Quevillon, 2009; Grunert, Weis, Smucker, & Christianson, 2007; Raabe, Ehring, Marquenie, Olff, & Kindt, 2015), but also for various other psychological disorders such as depression (e.g., Brewin et al., 2009; Wheatley & Hackmann, 2011), personality disorder (e.g., Arntz, 2011; Weertman & Arntz, 2007), and social anxiety disorder (e.g., Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Strachan, Hyett, & McEvoy, 2020; Wild & Clark, 2011).

ImRs aims to reduce the impact of distressing memories and mental images on emotions and intrusive re-experiencing by changing (the meaning of) these memories or images in imagination. First, aversive memories or mental images and associated emotional responses are reactivated. This reactivation seems necessary to later address the dysfunctional emotions in treatment (Arntz, 2012; Dibbets & Arntz, 2016). Second, ImRs treatment protocols then focus on changing the aversive memories into less distressing and more benign mental images according to the patient's individual needs (Arntz, 2012; Holmes et al., 2007). In the original ImRs protocols (Arntz & Weertman, 1999; Smucker et al., 1995), ImRs is conducted in three phases: During Phase 1, the patient imagines the original traumatic scene as experienced from the child's perspective. The actual rescripting takes place in Phases 2 and 3. In Phase 2, the patient rescripts the traumatic scene by imagining intervening from the adult's perspective (e.g., disempowering the perpetrator alone or with the help of others). In Phase 3, the patient imagines experiencing the adults' interventions from the child's perspective (Arntz & Weertman, 1999) or imagines nurturing the child from the adult's perspective (Smucker et al., 1995). In this last phase, the child's needs can be articulated and/or be met by the adult(s). Additionally, several variations of ImRs exist. These variations differ regarding aspects of the procedure as well as with respect to the content of the newly developed script. For example, several variations do not necessarily include a change in perspectives (Holmes et al., 2007). Furthermore, some

authors suggest that ImRs should be prepared by strategies of cognitive restructuring before the rescripting part (e.g., Wild & Clark, 2011). Moreover, it has been suggested that during Phase 2 the patient may not only imagine the adult self intervening, but can also imagine others (e.g., police, therapist, Superman) as helpers acting in the newly developed script (Arntz, 2012; Arntz & Weertman, 1999; Smucker et al., 1995). The latter may be helpful and necessary for severely distressed patients, who may not feel powerful enough to intervene themselves. In line with previous experimental research on ImRs (Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012; Seebauer, Froß, Dubaschny, Schönberger, & Jacob, 2014), the ImRs procedure used in the present thesis was adapted for the analogue setting and therefore did not include different phases with change of perspective (i.e., changing negative mental images into benign ones by rescripting the sequence of events to a more positive outcome, without explicitly switching between different perspectives of the self) and no cognitive restructuring was conducted before the rescripting. Whereas participants in **Study I** and **II** of the present thesis were not explicitly instructed to imagine either themselves or helpers acting in the newly developed script (i.e., both was allowed), **Study III** systematically investigated these two different ImRs approaches (i.e., the self actively bringing about change vs. helpers intervening).

In several experimental and clinical studies, ImRs has been proven to be an effective treatment for aversive emotional memories (for a review, see Arntz, 2012; for a meta-analysis, see Morina et al., 2017). Laboratory studies using trauma analogues revealed that ImRs effectively reduces short-term negative emotions (Seebauer et al., 2014). Additionally, it successfully prevented the development of experimentally induced intrusive memories (Hagenaars & Arntz, 2012). These results are supported by clinical studies showing that ImRs is effective in the treatment of various psychological disorders such as PTSD, depression, and anxiety disorders (Arntz, 2012; Morina et al., 2017).

Research on the effects of ImRs typically compares the technique to exposure-based interventions, which to date represent the state-of-the-art treatment for PTSD and associated intrusive re-experiencing. During imaginal exposure (IE), patients repeatedly confront their distressing memories of the traumatic event in their imagination (Cusack et al., 2016; Rothbaum & Schwartz, 2002). Although the efficacy of exposure-based therapies in the treatment of PTSD has been proven by a multitude of studies (for reviews, see e.g., McLean & Foa, 2011; Powers, Halpern, Ferenschak, Gillihan, & Foa, 2010; Rauch, Eftekhari, & Ruzek, 2012), challenges and concerns have increasingly been raised and discussed. First, even though IE is highly effective in the treatment of fear-based emotions, its efficacy with respect to non-fear emotions such as anger or guilt seems to be limited (Arntz, Tiesema, & Kindt, 2007; Grunert et al., 2007).

Second, as mentally reliving past traumatic events is often experienced as highly distressing by patients, they relatively often drop out of IE treatment (Arntz et al., 2007; Swift & Greenberg, 2014). Third, therapists often report negative attitudes towards IE and thus, do not routinely use it in clinical practice (Becker, Zayfert, & Anderson, 2004). Besides its general efficacy in the treatment of various emotional disorders (Morina et al., 2017), ImRs might also overcome some of the problems associated with IE therapy. Experimental studies revealed that ImRs is experienced as less distressing than exposure-based interventions (Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012). Additionally, in the treatment of PTSD, ImRs seems to be superior to exposure-based interventions in changing non-fear negative emotions such as anger and guilt (Arntz et al., 2007; Grunert et al., 2007) and in reducing drop-out rates (Arntz et al., 2007).

To date, there is significant variation across studies regarding the interventions that are referred to as *imagery rescripting* (Arntz, 2012; Edwards, 2007; Holmes et al., 2007) and no uniform guidelines exist on how to optimally implement the technique. As a consequence, ImRs is often applied differently by researchers and clinicians. More systematic research into different variants of ImRs has just recently begun and is still scarce. Understanding how ImRs works best may enable us to optimize the treatment technique and to develop guidelines for clinical practice. Thus, more research into working mechanisms and different ImRs approaches is clearly needed. Several potential mechanisms have been discussed that may promote change in ImRs (for a discussion see, Arntz, 2012). As the present thesis focuses on memory mechanisms that may underlie ImRs as well as the role of self-efficacy and mastery in ImRs approaches, these topics will be discussed in detail in the following sections.

Memory Mechanisms Underlying Imagery Rescripting

It is generally agreed that ImRs changes emotional memories (e.g., Arntz, 2012). However, systematic research into underlying memory mechanisms has just recently begun. Two different memory processes have been discussed that may play a key role in ImRs. On the one hand, it has been proposed that ImRs works through inhibitory learning, the same mechanism that is supposed to underlie exposure-based interventions (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Foa & Kozak, 1986). This is in line with Brewin's retrieval competition hypothesis: According to this hypothesis, ImRs leads to the formation of a new, alternative memory representation (Brewin, 2006). When later presented with retrieval cues, this new memory competes with the original, distressing memory. Thus, both memories

may be activated, which could explain relapse even after successful treatment (Brewin, 2006; Dibbets, Poort, & Arntz, 2012; Vervliet, Craske, & Hermans, 2013).

On the other hand, it has been suggested that ImRs may directly change the meaning of the original memory representation by a revaluation process (Arntz, 2012). Based on modern learning theory (e.g., Davey, 1997; Mineka & Zinbarg, 2006), a memory representation may be changed if new information is given that is incongruent to the original memory. It has been shown that successfully consolidated memories can be destabilized upon retrieval, making them prone to updating processes (Beckers & Kindt, 2017; Exton-McGuinness, Lee, & Reichelt, 2015). The updated memory can then be restored with the new information, a process, which is referred to as memory reconsolidation (for an overview see Beckers & Kindt, 2017; Schwabe, Nader, & Pruessner, 2014). This may change the behavioral and emotional responding to the memory (Beckers & Kindt, 2017; Elsey & Kindt, 2017). Given that ImRs aims to actively change the storyline of an aversive memory, it might be one method to generate new, corrective information that can then be incorporated in the original memory. For example, the meaning of an aversive, trauma-related memory may be revaluated by more positive mental images of the self such as being powerful or protected and supported by others. This may promote feelings of security, mastery, self-efficacy, and/or self-compassion. In line with the assumption that ImRs may change the meaning of the original memory representation, preliminary results on the effect of ImRs on memory consolidation indicate that ImRs may reduce the negative valence of memory representations and memory-related negative emotional responding (Dibbets, Lemmens, & Voncken, 2018; Dibbets et al., 2012). However, the effects of ImRs on already consolidated memories (i.e., the effects on memory resconsolidation) have not yet systematically been studied.

The Role of Mastery and Self-Efficacy in Imagery Rescripting Treatment

Based on the proposition that ImRs leads to a revaluation of the aversive memory, incorporating increased feelings of mastery and/or self-efficacy has been discussed as a means to change the meaning of the original memory (Arntz, 2012; Kunze, Lancee, Morina, Kindt, & Arntz, 2019; Strohm, Siegesleitner, Kunze, Ehring, & Wittekind, 2019). PTSD is associated with negative cognitions about the world as being dangerous and the self as being helpless and incompetent (e.g., Ehlers & Clark, 2000; Foa & Rothbaum, 1998). Additionally, involuntary intrusive mental images as typically observed in PTSD are usually experienced as uncontrollable. Given that feelings of mastery and self-efficacy seem to mediate posttraumatic

recovery (Benight & Bandura, 2004; Luszczynska, Benight, & Cieslak, 2009; Samuelson, Bartel, Valadez, & Jordan, 2017), social cognitive theory of PTSD proposes that restoring feelings of mastery and self-efficacy might be crucial mechanisms underlying successful treatments (Benight & Bandura, 2004; Samuelson et al., 2017). In line with this proposition, it has been argued that increasing mastery and/or self-efficacy might also be one of the key working mechanisms of ImRs (Kunze, Lancee, Morina, Kindt, & Arntz, 2016; Long & Quevillon, 2009; Smucker et al., 1995). ImRs might increase the patient's sense of mastery and self-efficacy by gaining control over distressing intrusive mental images and by implementing more positive images of the self as being powerful and capable of taking action that the individual might not have been able to express during the traumatic situation (Arntz, 2012; Kunze et al., 2016).

However, it remains an empirical question how exactly an increase in feelings of mastery and self-efficacy can be facilitated in treatment. During ImRs, therapists typically encourage patients to imagine themselves bringing about change in the newly developed script or – if they do not feel powerful enough – to imagine helpers bringing about the change (Arntz, 2012; Arntz & Weertman, 1999; Smucker et al., 1995). It has been discussed, whether patients necessarily need to imagine themselves playing an active role in the rescripted scene in order to increase feelings of mastery and self-efficacy or if they could rather play a more passive role by imagining others acting in the newly developed script (Arntz, 2012). According to social cognitive theory, social modeling promotes observational learning (Bandura, 1999), which might also more indirectly enhance patients' feelings of mastery and self-efficacy by observing helpers acting. However, the level of activity the patient needs to play in the newly developed script in order to increase feelings of mastery and/or self-efficacy has not yet systematically been studied.

Research Paradigms to Investigate Treatment Effects and Working Mechanisms in Experimental Settings

For the investigation of treatment effects and potentially underlying working mechanisms of psychological interventions, experimental analogue studies have successfully been used. In analogue studies, the development or maintenance of experimentally induced symptoms, treatment effects, and causal relationships between symptoms, treatments, and potential working mechanisms can be studied in healthy samples under highly controlled and standardized conditions (for reviews, see Forsyth & Zvolensky, 2002; Scheveneels, Boddez,

Vervliet, & Hermans, 2016; Van den Hout, Engelhard, & McNally, 2017; Vervliet & Raes, 2013).

The trauma film paradigm (TFP) is a valuable research paradigm that has often been used in analogue studies on PTSD. Within the TFP, healthy participants are presented with aversive films depicting traumatic events (e.g., accidents, interpersonal violence). These films are known to elicit analogue posttraumatic reactions such as negative emotional responding, high levels of distress, and short-lived intrusive mental images (Arnaudova & Hagenaars, 2017; Weidmann, Conradi, Gröger, Fehm, & Fydrich, 2009). The TFP ensures high experimental control over the symptom-eliciting stressor and is therefore generally regarded as a good laboratory analogue for traumatic experiences (for reviews on the TFP see, Arnaudova & Hagenaars, 2017; Holmes & Bourne, 2008; Weidmann et al., 2009). By controlling the traumatic situation, causal relationships between variables can be investigated. Additionally, high experimental control increases the comparability of results across TFP studies. Furthermore, the prospective study design allows for the examination of responses towards an analogue traumatic experience without memory biases as observed in retrospective studies (Merckelbach, Langeland, de Vries, & Draijer, 2014). Even though the TFP elicits emotional responses towards aversive films, these responses do not reach the level of responses towards real life traumatic events and symptoms seem to decline quickly (James et al., 2015). Several studies have used the TFP to investigate the treatment effects of ImRs (e.g., Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012; Seebauer et al., 2014).

Recent studies on ImRs have combined the TFP with Pavlovian fear-conditioning procedures (e.g., Dibbets et al., 2018; Kunze, Arntz, & Kindt, 2019), as this combination of paradigms allows not only for the investigation of subjective but also objective outcomes (e.g., psychophysiological measures). Pavlovian fear-conditioning is based on learning theory (e.g. Davey, 1997; Mineska & Zinbarg, 2006). Within this theoretical framework is has been shown that when a neutral stimulus (NS) is repeatedly connected to a fear-eliciting unconditioned stimulus (UCS), the NS becomes a conditioned stimulus (CS) leading to a conditioned fear response (CR). The CS can then elicit the CR even in the absence of the UCS by reactivating the mental representation of the UCS and the CS-UCS association. After successful exposure treatment, the CS usually does not evoke the CR any more. However, relapse (i.e., return of fear) can frequently be observed after exposure therapy, possibly due to a reactivation of the original distressing memory (Brewin, 2006; Dibbets et al., 2012; Vervliet et al., 2013). Determinants that may trigger the original UCS and UCS-CS association can for example be changes of context (e.g., to situations outside the therapy) or mere passage of time (Brewin,

2006; Dibbets et al., 2012; Vervliet et al., 2013). Within fear-conditioning procedures, the return of fear has often been investigated by UCS reinstatement testing (Dirikx, Hemans, Vansteenwegen, Baeyen, & Eelen, 2004, 2007; Haaker, Golkar, Hermans, & Lonsdorf, 2014). During UCS reinstatement testing, return of fear is tested by assessing the fear response (CR) to the CS after an unexpected presentation of the UCS. According to the devaluation hypothesis proposed by Arntz (2012), ImRs might work through UCS-devaluation. If ImRs indeed changes the meaning of the UCS, the unexpected presentation during UCS-reinstatement testing should not elicit the CR. Accordingly, treatment effects of ImRs may be more stable and less sensitive to a return of fear, e.g., after a change of context, when compared to exposure-based intervention (Arntz, 2012). Whereas classical Pavlovian fear-conditioning paradigms usually use electric shocks as UCS, recent studies on ImRs combined a fear-conditioning procedure with the TFP in order to model complex associative fear memories more similar to memories of real-life trauma (Kunze et al., 2015, 2019). In these study designs, conditioning stimuli (UCS, CS) derive from the aversive film (i.e., pictures, short movie fragments, sounds). So far, studies using the adapted fear-conditioning paradigm primarily investigated the effects of ImRs on memory consolidation by using single- or two-day procedures. To test treatment effects on memory reconsolidation, multiple-day paradigms are needed with an interval of at least one day between memory induction and treatment or treatment and UCS reinstatement testing respectively, in order to allow for memory consolidation after memory induction and memory reconsolidation after the intervention (Dirikx et al., 2004, 2007; Haaker et al., 2014).

Aims and Outline of the Present Thesis

The present thesis aims to improve our general understanding of the effects and potential working mechanisms of ImRs for distressing memories. For this purpose, three experimental studies were conducted which examine the effects of ImRs on artificially induced emotional memories. The TFP was used as a means to induce distressing memories and analogue posttraumatic reactions. In all three studies, ImRs was compared to an active treatment condition (imaginal exposure-based imagery rehearsal) and a no-intervention control condition. As previous experimental research mainly focused on the investigation of the preventive effects of ImRs during memory consolidation, **Studies I** and **II** were designed to examine the effects of ImRs on already consolidated memories during memory reconsolidation. By using a multiple-day TFP that allowed for memory consolidation prior to treatment, **Study I** aimed to investigate therapeutic effects of ImRs on film-related intrusive memory frequency and

emotional responding such as subjective distress and negative fear and non-fear emotions. **Study II** focused on the investigation of reconsolidation processes potentially underlying ImRs treatment. In order to model complex associative fear memories, an adapted multiple-day research paradigm was used that combined a fear-conditioning procedure with a TFP. As, to date, no uniform guidelines exist on how to optimally implement ImRs in clinical practice and research, **Study III** was designed to advance our understanding on the effectiveness of different ImRs approaches, namely an active and a passive ImRs protocol. **Study III** addressed the empirical question whether patients/participants need to imagine playing an active role in the new script or whether they can also imagine themselves as passive bystanders observing others acting in the imagined situation. Additionally, **Study III** aimed at identifying potential working mechanisms underlying the different ImRs approaches, namely the increase in feelings of mastery and/or self-efficacy.

Study I

Effects of Imagery Rescripting on Consolidated Memories of an Aversive Film

Abstract

Background and objectives: Imagery rescripting (ImRs) is a promising intervention targeting emotional memory. Previous analogue studies have mainly investigated effects of ImRs during memory encoding and consolidation; experimental research on the effects and mechanisms of change in ImRs targeting consolidated memories is largely missing. The present study aimed to investigate effects of ImRs on consolidated memories using a multiple- day trauma film paradigm.

Methods: Eighty-eight participants were randomly assigned to either ImRs, imagery rehearsal (IRE), or no intervention control (NIC). In Session 1, participants watched an aversive film. In Session 2 (24h after Session 1), the analogue trauma memory was reactivated and the intervention took place. Participants reported intrusive memories of the aversive film for one week and then returned to the laboratory for a follow-up (Session 3).

Results: Compared to IRE, ImRs was experienced as less distressing and elicited less negative emotions. In addition, ImRs accelerated the decline of intrusive memories when compared to NIC. However, ImRs, IRE, and NIC did not differ with respect to the total number of intrusive memories during the week following the intervention.

Limitations: There was a floor effect of intrusive memories, which may have obscured a potential superiority of the active interventions over NIC.

Conclusions: Adding to the current literature on ImRs as an intervention for emotional memories, the current study underscores that a multiple-day trauma film paradigm can be used to investigate the short-term efficacy and working mechanisms of ImRs, but also points toward useful modifications to the paradigm.

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Study II

Effects of Imagery Rescripting on Memory Reconsolidation Processes: An Experimental Fear-Conditioning Study

Effects of Imagery Rescripting on Memory Reconsolidation Processes: An Experimental Fear-Conditioning Study

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Abstract

Background: Imagery rescripting (ImRs) is a promising technique that has proven to be effective in the treatment of various emotional disorders. Research into the working mechanisms including memory processes underlying ImRs is still scarce.

Methods: In order to investigate memory mechanisms underlying ImRs, the study used an associative fear-learning paradigm (Kunze, Arntz, & Kindt, 2015). On Day 1, participants were presented with an aversive film followed by a fear-conditioning procedure. To allow for memory consolidation, participants received ImRs, exposure-based imagery rehearsal (IRE), or no intervention (NIC) one day after memory induction. Intervention effects on subjective and objective measures were examined one day after treatment to allow for memory reconsolidation to occur.

Results: Contrary to the expectations, return of fear towards the conditioned stimulus on Day 3 could only be detected on subjective distress, but not on psychophysiological measures. No differences between conditions could be observed.

Conclusions: While all conditions appeared to prevent a return of fear regarding the emotional component of the fear response (as reflected by psychophysiological measures), participants were still cognitively aware of the threatening stimulus (as reflected by subjective distress). Procedural limitations that might account for the unexpected results are discussed.

Keywords: imagery rescripting, fear-conditioning, trauma film, fear memory, reconsolidation

Introduction

Aversive mental images are highly prevalent in anxiety disorders and PTSD (e.g., Ehlers & Clark, 2000; Hackmann & Holmes, 2004; Holmes & Mathews, 2010). Recently, imagery rescripting (ImRs) has been introduced as a means to change emotional memories, offering a promising treatment alternative to state-of-the-art exposure-based therapies (Arntz, 2012; Holmes, Arntz, & Smucker, 2007; Smucker, Dancu, Foa, & Niederee, 1995). In ImRs, distressing, aversive mental images are first reactivated and subsequently modified in an individuals' imagination into more benign and less distressing images. Exposure-based treatments are often experienced as highly distressing by patients and therapists, which results in relatively high drop-out rates (Arntz, Tiesema, & Kindt, 2007; Bradley, Greene, Russ, Dutra, & Westen, 2005; Swift & Greenberg, 2014). In contrast, ImRs appears to be experienced as less distressing and accompanied by less negative emotions during the intervention (e.g., Arntz et al., 2007; Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012), resulting in lower drop-out rates (Arntz et al., 2007). Even though there is growing evidence, which suggests ImRs to be an effective treatment for various psychological disorders (for a meta-analysis, see Morina, Lancee, & Arntz, 2017), research into the working mechanisms underlying ImRs has just recently begun.

There is a common assumption that ImRs changes emotional memories (for a review, see Arntz, 2012). Different hypotheses have been proposed about *how* ImRs may modify these memories. According to classical fear conditioning a neutral stimulus (NS) can become a conditioned stimulus (CS), if it is associated with an aversive, fear-eliciting unconditioned stimulus (UCS). Consequently, encounters with the CS may lead to a conditioned fear response (CR) even in the absence of the UCS. According to modern learning theory (e.g. Davey, 1997; Mineska & Zinbarg, 2006), it is assumed that the CR is not directly evoked by the CS, but by (re)activating a mental representation of the UCS and the CS-UCS association. Based on the contemporary condition account, two different hypotheses regarding the working mechanisms of ImRs have been proposed. On the one hand, it has been suggested that ImRs may work through inhibitory learning, the same process that is known to underlie exposure-based therapies such as imaginal exposure (Bouton, 2004; Brewin, 2006; Brewin, Gregory, Lipton, & Burgess, 2010; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014). Specifically, it has been hypothesized that ImRs may lead to the formation of an alternative memory trace that incorporates a new, more positive memory representation of the original memory (CS-noUCS association), while the original memory (CS-UCS association) remains intact (Brewin, 2006;

Brewin et al., 2010). When subsequently presented with retrieval cues, the new memory representation competes for retrieval with the original, distressing memory (e.g., Holmes & Mathews, 2010). Thus, either memory may be retrieved. Research on imaginal exposure therapy indicates that determinants triggering the original, dysfunctional memory can, for example, be changes of context (e.g., situations outside the therapy context) or mere passage of time (i.e., spontaneous recovery), which in turn may lead to a return of fear (i.e., relapse) even after successful treatment (Brewin, 2006; Dibbets, Poort, & Arntz, 2012; Vervliet, Caske, & Hermans, 2013). Based on the assumption that ImRs works through the formation of a competing memory trace, its treatment effects might be sensitive to relapse.

On the other hand, it has been argued that ImRs may change (i.e., devaluate) the meaning of the consolidated original, aversive memory (UCS) by implementing new, corrective information (i.e., UCS-devaluation; e.g., Arntz, 2012) rather than facilitating the formation of a new memory trace. Once an emotional memory has been consolidated, it can be destabilized upon retrieval (Beckers & Kindt, 2017; Exton-McGuinness, Lee, & Reichelt, 2015). In this instable state, stimulus devaluation (i.e., changing the meaning of the stimulus) can occur if new information is presented that is incongruent with the original memory (Davey, 1989). The updated memory can then be restored, during a process which is referred to as memory reconsolidation (for an overview, see Beckers & Kindt, 2017; Schwabe, Nader, & Pruessner, 2014). Given that patients actively change the content of the trauma memory during ImRs and therefore generate new information about the memory, ImRs might work by updating the memory via stimulus devaluation processes (Arntz, 2012). If ImRs would indeed directly modify the meaning of the original memory representation during reconsolidation, it may increase the generalizability of the treatment effects to contexts outside therapy. This may lead to reductions in negative emotional responses when confronted with memory triggers and reduce the risk of relapse (Arntz, 2012). Recent experimental studies provide preliminary evidence that ImRs reduces the negative valence of the mental representation of aversive stimuli as well as associated negative emotional responding (Dibbets, Lemmens, & Voncken, 2018; Dibbets et al., 2012). These findings support the proposition that ImRs may directly change the meaning of the aversive memory by stimulus devaluation processes.

However, experimental research on the effects and mechanisms underlying ImRs is currently limited to short-term effects by using single- or two-day study designs. In these designs, the interventions are typically employed on the same day as fear learning (e.g., Dibbets et al., 2018; Dibbets et al., 2012; Hagenaars & Arntz, 2012; Kunze, Arntz, & Kindt, 2019), thus investigating the effects of ImRs on memory encoding and/or consolidation rather than on

reconsolidation processes. To our knowledge, only one study investigated ImRs as a means to modify memory during the clinically more relevant process of reconsolidation (Siegesleitner, Strohm, Wittekind, Ehring, & Kunze, 2019). The study used a multiple-day trauma-film paradigm allowing for consolidation of the original memory to occur by employing ImRs 24h after memory induction, and investigating treatment effects 24h after the intervention. Results showed that ImRs is associated with less subjective distress and less negative emotionality. However, the measures used in this study were not suitable to draw strong conclusions about memory updating processes during reconsolidation.

Effects of interventions on memory reconsolidation are typically studied by investigating the return of fear using multiple-day fear-conditioning paradigms. These paradigms allow for the investigation of intervention effects not only on subjective (e.g., distress, affect) but also objective outcomes (e.g., psychophysiological measures). Classical Pavlovian fear-conditioning paradigms have intensely been used to study memory processes underlying the return of fear, for example, using UCS reinstatement techniques (Dirikx, Hemans, Vansteenwegen, Baeyen, & Eelen, 2004; Haaker, Golkar, Hermans, & Lonsdorf, 2014). During UCS reinstatement testing, the re-occurrence (reinstatement) of the CR is evaluated when unexpectedly presenting the UCS following successful fear extinction. In such studies, the strength of fear reinstatement serves as an indicator of return of fear (i.e., relapse), and therefore offers a viable means to evaluate the treatment effects on fear memory of any intervention previously employed.

Based on a series of analogue studies conducted by Kunze and colleagues (2019), the present study aimed to extend previous findings on the effects of ImRs on fear memory consolidation to *re*consolidation processes. To model complex associative fear memories, an adapted fear-learning paradigm was used as suggested by Kunze, Arntz, and Kindt (2015). In this paradigm, multiple-day Pavlovian fear conditioning was combined with the trauma film method. The experiment consisted of three sessions on three consecutive days, enabling the investigation of reconsolidation processes. Fear acquisition took place on Day 1, where an aversive film was presented, followed by a fear-conditioning phase using a short segment of the most aversive scene of the film as UCS and a picture from the aversive film as reinforced conditioned stimulus (CS+). In order to allow for reconsolidation to occur, the intervention was conducted 24h later (Day 2). Participants were randomly allocated to ImRs, exposure-based imagery rehearsal (IRE) as an active imagery control condition, or no-intervention control (NIC). In ImRs, participants devaluated the UCS by rescripting the aversive film memory, while participants in IRE were repeatedly exposed to their memory of the UCS. Fear reinstatement

testing took place on Day 3. Fear responses were assessed using self-report and psychophysiological measurements.

In line with previous findings supporting the proposition that ImRs directly changes the meaning of the aversive memory by devaluating the mental representation of the UCS (Dibbets et al., 2018; Dibbets et al., 2012), we hypothesized that participants in ImRs would show less fear reinstatement when compared to participants in IRE and NIC.

Methods

Participants

One hundred and fifteen healthy participants were included in the study (56.5 % female). Prior to testing, written informed consent was obtained and participants were screened for exclusion criteria (age < 18 or > 35 years, history of sexual/physical abuse, current diagnosis of a mental disorder, acute suicidal tendencies, current psychological/psychiatric treatment, pregnancy, epilepsy, severe cardiovascular disease, life-time diagnosis of PTSD, psychosis, or bipolar disorder). Participants were randomly assigned to ImRs (n = 38), IRE (n = 38), or NIC (n = 39), stratified by gender. Age ranged from 18 to 35 years (M = 24.14, SD = 3.77), and groups did not differ regarding age, $F(2, 112) = 1.62$, $p = .202$, $\eta_p^2 = 0.03$, or trait anxiety (State Trait Anxiety Inventory; Laux, Glanzmann, Schaffner, & Spielberger, 1981; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), $F(2, 112) = 2.54$, $p = .084$, $\eta_p^2 = 0.04$. Also, groups did not differ on valence and arousal ratings of the conditioning stimuli (CS+/CS-) at baseline, all Fs(2, 112) < 2.82, all ps > .064, all η_p^2s < 0.05. Participants were compensated with either partial course credit or monetary reimbursement (25 €). The study was approved by the local Ethics Committee (09_Siegesleitner_b).

Materials

Aversive Film

A 12-min compilation of different scenes from the movie “Salo, or the 120 Days of Sodom” (Pasolini, 1975) was used as an aversive film to induce analogue posttraumatic reactions and to create a relevant context between the reinforced CS and the UCS (Kunze et al., 2015). The aversive film depicted a group of teenagers being kidnapped and then humiliated, abused, physically and sexually harassed, and tortured by four men (see also Kindt, Van den Hout, & Buck, 2005; Kunze et al., 2019; Weidmann, Conradi, Gröger, Fehm, & Fydrich, 2009).

At the end of the compilation, one of the perpetrators puts nails into food, which he forces a girl to eat. The girl screams loudly and blood runs out of her mouth.

Conditioning Stimuli

The unconditioned stimulus (UCS) was a 3-s scene originating from the aversive film. The UCS depicted the girl screaming loudly after having eaten the food containing nails. The conditioned stimuli (CSs) consisted of two different pictures, which were matched on picture quality, color, and valence. A picture of the face of the perpetrator who put the nails into the food was used as the reinforced CS (CS+). A picture of the face of a man unrelated to the aversive film served as the unreinforced CS (CS-). During fear acquisition (see Section 2.6), the CS+ was paired with the UCS with a 100% contingency, whereas the CS- was never paired with the UCS. The CSs were presented in the middle of the screen against a black background.

Physiological Measures

Fear-Potentiated Startle (FPS)

Psychophysiological data were recorded using a 16-channel amplifier (Twente Medical Systems International [TMSi], EJ Oldenzaal, The Netherlands) and the software package Polybench 1.22 (TMSi) using a sampling rate of 1024 Hz. Fear-potentiated startle (FPS) was measured via electromyography (EMG) of the left orbicularis oculi muscle using two 1 mm sintered Ag/AgCl electrodes filled with electrolyte gel (Sonogel). Electrodes were attached approximately 1 cm below the pupil and 1 cm below the lateral canthus (Fridlund & Cacioppo, 1986). The startle probe was a 102-104 db, 50 ms burst of broadband white noise delivered binaurally through headphones (Sennheiser HD 280 Pro) (see e.g., Kindt, Soeter, & Vervliet, 2009; Kunze et al., 2015; Sevenster, Beckers, & Kindt, 2013). A notch filter was set at 50 Hz to remove unwanted interference. Raw data were band-pass filtered (28-500 Hz, Butterworth 4^{th} order; Blumenthal, Cuthbert, Filion, Hackley, Lipp, & Van Boxtel, 2005; see also Kunze et al., 2015, 2019). The conditioned fear response was identified as the maximum amplitude of the eye blink reflex within 200 ms after the presentation of the startle probe.

Skin conductance response (SCR)

Skin conductance level (SCL) was obtained by applying a constant voltage (0.5V) via two 5 mm Ag/AgCl electrodes that were attached to the medial phalanges of the index and ring

finger of the non-dominant hand. The signal was further processed using ANSLAB (Blechert, Peyk, Liedlgruber, & Wilhelm, 2016). Skin conductance response (SCR) to a stimulus was computed as the difference between the average baseline (i.e., 2 s prior to stimulus onset) and the maximum SCL during stimulus presentation (see also, Pineles, Orr, & Orr, 2009).

Subjective Measures

Mood Ratings

State (STAI-S) and trait anxiety levels (STAI-T) were assessed using the State Trait Anxiety Inventory (STAI; Laux et al., 1981; Spielberger et al., 1983). Change in negative (PANAS-NA) and positive affect (PANAS-PA) in response to the aversive film, the intervention, and the conditioning procedure was measured by the Positive and Negative Affect Schedule (PANAS; Krohne, Egloff, Kohlmann, & Tausch, 1996; Watson, Clark, & Tellegen, 1988). In the current study, internal consistencies were acceptable to excellent (STAI-T: Cronbach's α = .88, STAI-S: Cronbach's α = .86-.92, PANAS-PA: Cronbach's α = .78-.89, PANAS-NA: Cronbach's α = .76-.90).

Valence and Arousal Ratings

Self-assessment manikins (SAM; Bradley & Lang, 1994) were used to assess emotional valence and arousal with respect to the CSs.

Online Distress

Subjective distress to the CSs was assessed on a continuous, vertical green (*not at all distressed*) to red (*very distressed*) colored rating scale presented on the computer screen next to the CSs (Soeter & Kindt, 2012; Kunze et al., 2015, 2019). For each CS presentation, participants rated their subjective distress within 5 s (i.e., before the startle probe was presented) by indicating a position on the scale using the mouse. When presented with the next stimulus, the mouse cursor automatically returned to the middle of the scale.

Interventions

Participants in ImRs and IRE were instructed to close their eyes and to vividly imagine everything that followed. The aversive film-induced memory was briefly reactivated by the experimenter by means of a short guided re-imagination of the hotspot of the scene. Participants

were then instructed to either rescript (ImRs) or rehearse (IRE) the aversive film and to describe their mental images out loud from the first person perspective, in present tense, and with as much sensory details as possible. The experimenter guided the imagination using standardized instructions and questions. In order to address the mental representations of the conditioning stimuli, the experimenter ensured that the CS+ (perpetrator) and the UCS (screaming girl) were explicitly mentioned at least twice during the interventions. After 8-12 min, the experimenter ended the imagination.

Imagery Rescripting

Participants in ImRs were instructed to change the course of the aversive film in any way they wished (realistic or unrealistic), as long as it resulted in a more satisfying outcome. Participants were encouraged to imagine that the perpetrators were disempowered and the victims were rescued.

Imagery Rehearsal

Participants in IRE were instructed to vividly re-experience the aversive film in their imagination.

Control Condition

Participants in NIC had a 12-min break during which they were provided with neutral magazines.

Procedure

An instructed three-day differential fear conditioning procedure was used in the present study (Figure 1). Throughout the experiment, stimuli (CS+, CS-, and noise alone [NA]) were presented for 8 s, startle probes were presented 7.5 s after stimulus onset. Order of trial type was randomized within blocks. The inter-trial intervals varied randomly between 15 s, 20 s, and 25 s. Reinforced CS+ were followed by the presentation of the 3-s UCS after 500 ms.

Day 1. First, participants were screened for exclusion criteria, written informed consent was obtained, and the STAI-T was administered. Then, EMG and SCR electrodes were attached. Afterwards, baseline measures of PANAS, STAI-S, and SAM with respect to CS+ and CS- were assessed (t1) and participants were instructed to rate their distress during the CS

presentations throughout the experiment. Before testing, ten NA startle probes were presented in order to allow for habituation of the startle response. Subsequently, baseline differences in responding were assessed by single presentations of the CSs (both unreinforced) and the NA. Before the presentation of the aversive film (Section 2.2.1) and fear acquisition, participants were explicitly instructed that after the film, two pictures would be presented, and that one of the pictures would always be followed by a short movie fragment, whereas the other picture would never be followed by a movie fragment. Next, participants were presented with the aversive film, immediately followed by fear acquisition. During acquisition, CS+ (all reinforced), CS-, and NA were each presented four times. Afterwards, PANAS, STAI-S, and SAM with respect to the CSs were administered (t2).

Day 2. The second part of the experiment took place one day after fear acquisition in order to allow for memory consolidation of the acquired fear association (Dudai, 2004). After attachment of EMG and SCR electrodes, baseline measures of PANAS and STAI-S were assessed (t3). Participants were then instructed about the imagery exercise and the experimenter demonstrated an example (imagining today's breakfast). Next, ten NA startle probes were presented to allow startle response to habituate. The aversive memory was reactivated by means of a short (1 min 45 sec) standardized, audio-guided imagination of the aversive film presented via headphones (adapted from Kunze et al., 2019). Then, the fear association acquired on Day 1 was reactivated using a single presentation of the CS+ (unreinforced), followed by a 10-min break allowing for memory reconsolidation to initiate (Ågren et al., 2012; James et al., 2015; Nader et al., 2000; Schiller et al., 2010). After the break, participants either received ImRs, or IRE, or were presented with neutral magazines to read. At the end of the experimental session in Day 2, PANAS and STAI-S were assessed (t4).

Day 3. The third part of the experiment took place one day after the intervention, and two days after fear acquisition. PANAS and STAI-S were assessed (t5) and the EMG and SCR electrodes were attached. During the habituation phase, participants were presented with ten NA startle probes. Subsequently, the CS+ (unreinforced) and the CS- were each presented once, followed by the presentation of the UCS after 19 s. 18 s after this unexpected UCS presentation, participants were again presented with one single CS+ (unreinforced) and CS-. Finally, PANAS, STAI-S, and SAM with respect to the CSs were assessed (t6) and participants were debriefed.

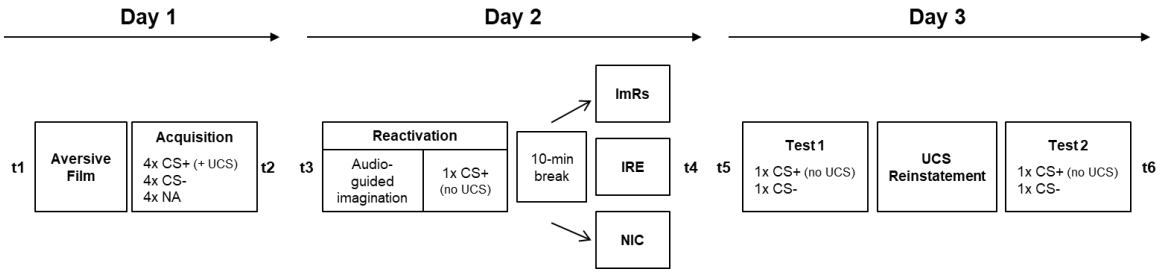

Figure 1. Overview of the study procedure.

Data Reduction and Statistical Analyses

Baseline differences between conditions (ImRs vs. IRE vs. NIC) were investigated by univariate ANOVAs on age, STAI-T, and SAM ratings. Changes in positive and negative affect (PANAS) and STAI-S scores were analyzed using mixed repeated-measures ANOVAs with between-subjects factor Condition (ImRs vs. IRE vs. NIC) and within-subjects factor Time (t1 vs. t2 or t3 vs. t4 or t5 vs. t6). Repeated-measures ANOVAs with between-subjects factor Condition (ImRs vs. IRE vs. NIC) and within-subjects factor Time (t1 vs. t2 or t2 vs. t6) were conducted for valence and arousal ratings (SAM) of the CSs.

Fear potentiated startle (FPS) data were z-transformed prior to analyses in order to reduce between-subject variability (Kunze et al., 2015, 2019; Visser, Kunze, Westhoff, Scholte, & Kindt, 2015). Raw skin conductance response (SCR) data underwent square-root transformation with reapplication of the negative sign for negative raw values (Braithwaite, Watson, Jones, & Rowe, 2013; Krypotos, Arnoudova, Effting, Kindt, & Beckers, 2015; Milad et al., 2006). To control for baseline differences between CS+ and CS- on online distress, baseline scores were subtracted from following distress ratings scores.

For the analyses of FPS, SCR, and online distress, mixed repeated-measures ANOVAs with between-subjects factor Condition (ImRs vs. IRE vs. NIC), and within-subjects factors Stimulus (CS+ vs. CS-, CS+ vs. NA) and Trial were calculated. Fear acquisition from the first (ACQ1) to the last acquisition trial (ACQ4) was investigated calculating repeated-measures ANOVAs with between-subjects factor Condition and within-subjects factors Stimulus (CS+ vs. CS-) and Trial (ACQ1 vs. ACQ4) for FPS, SCR, and online distress. Retention of the acquired fear memory (ACQ_mean) to reactivation on Day 2 (REACT) was examined on FPS and SCR using repeated-measures ANOVAs with between-subjects factor Condition and within-subjects factors Stimulus (CS+ vs. NA) and Trial (ACQ_mean vs. REACT). Transfer of the fear memory (ACQ_mean) to the first trial of reinstatement testing on Day 3 (Test1) was examined on FPS, SCR, and online distress using repeated-measures ANOVAs with between-

subjects factor Condition and within-subjects factors Stimulus (CS+ vs. CS-) and Trial (ACQ_mean vs. Test1). For the main hypothesis test, fear reinstatement from the first (Test1) to the second test trial on Day 3 (Test2) was investigated on FPS, SCR, and online distress using repeated-measures ANOVAs with between-subjects factor Condition and within-subjects factors Stimulus (CS+ vs. CS-) and Trial (Test 1 vs. Test2).

Following up on significant interactions, Bonferroni-corrected planned comparisons were performed for each condition or time point separately. Criterion for significance was set at $p < .05$ for all analyses. In ANOVAs, partial eta square (η^2) was used as effect size, in *t*-tests, Cohen's *d* was calculated.

Results

Mood Ratings

A manipulation check for fear acquisition on Day 1 revealed significant main effects of Time (t1 vs. t2) for STAI-S, F (1, 112) = 143.54, $p < .001$, $\eta_p^2 = 0.56$, negative affect, F (1, 112) = 147.76, $p < .001$, $\eta_p^2 = 0.57$, and positive affect, F (1, 112) = 171.36, $p < .001$, $\eta_p^2 = 0.61$. Repeated measures ANOVAs yielded neither a significant main effect of Condition nor a significant interaction effect for any of the measures, all Fs < 1.73, all ps > .18, all $\eta_p^2 < 0.03$. Thus, the fear learning procedure successfully induced negative emotionality and reduced positive affect across conditions.

The investigation of short-term effects of the conditions from pre- to post-intervention revealed significant Time (t3 vs. t4) x Condition interaction effects for STAI-S, positive, and negative affect, all Fs > 4.39, all ps < .02, all η_p^2s > 0.07, indicating between-group differences in response to the interventions. Post-hoc *t*-tests showed that STAI-S and negative affects significantly increased in ImRs, ts(37) > 3.46 , ps < .001 , Cohen's ds > 0.54, and IRE, ts(37) > 5.16, ps < .001 , Cohen's ds > 0.93, but did not change in NIC, ts(38) < 0.26, ps > .79, Cohen's ds < 0.04. Positive affect decreased in IRE, $t(37) = 4.12$, $p < .001$, Cohen's $d = 0.58$, and NIC, $t(38) = 4.58$, $p < .001$, Cohen's $d = 0.60$. No change in positive affect could be detected in ImRs, $t(37) = 0.10$, $p = .92$, Cohen's $d = 0.02$. Post-hoc planned comparisons for different time points showed that groups did not differ on any of the measures pre-intervention, all Fs < 1.11, all ps > .33, all η_p^2s < 0.02, but differed significantly post-intervention, all Fs > 5.32, all ps < .006, all η_p^2s > 0.09. Participants in ImRs reported more positive affect post-intervention than participants in IRE ($p = .005$). However, ImRs and IRE did not significantly differ regarding negative affect or state anxiety after the intervention (ps > .449). Results indicate that even

though ImRs and IRE both elicited similar levels of negative affect, at the same time, ImRs was associated with more positive affect than IRE. Participants in NIC showed less negative affect and less state anxiety post-intervention than participants in ImRs, *p*s < .009, and IRE, *p*s < .001, suggesting that NIC might have been superior to ImRs and IRE on the short-term effects on mood.

For reinstatement testing on Day 3 (t5 vs. t6), no group differences could be observed on STAI-S, positive affect, and negative affect, all *F*s < 1.39, all *p*s > .255, all η_p^2s < 0.02. Contrary to the expectations, the fear memory reactivation during reinstatement testing did not elicit an increase in subjective measures of negative affect or fear in any of the conditions.

Valence and Arousal Ratings

Successful fear learning during acquisition on Day 1 was reflected by significant main effects of Time (t1 vs. t2) for valence and arousal of CS+ and CS-. Arousal increased for CS+, $F(1, 112) = 127.39$, $p < .001$, $\eta_p^2 = 0.53$, whereas it decreased for CS-. CS+ valence was more negative after the film than at baseline, $F(1, 112) = 242.14$, $p < .001$, $\eta_p^2 = 0.68$, whereas CS- valence was more positive, $F(1, 111) = 54.51$, $p < .001$, $\eta_p^2 = 0.33$. Time x Condition interactions for CS+ valence and CS- arousal were non-significant, *F*s < 1.35, *p*s > .263, η_p^2s < 0.02. Surprisingly, repeated measures ANOVAs showed significant Time x Condition interaction effects for CS- valence, $F(1, 111) = 3.30$, $p = .041$, $\eta_p^2 = 0.06$, and CS+ arousal, $F(1, 112) = 3.16$, $p = .046$, $\eta_p^2 = 0.05$. Post-hoc tests revealed that the interaction effect for CS+ arousal ratings was driven by a significant difference between NIC and IRE ($p = .025$) with participants in NIC showing more arousal towards the CS+ post-film than participant in IRE ($p = .039$). No significant difference between conditions for valence of CS- could be detected after Bonferroni-correction. Results indicate that fear acquisition was successful across conditions.

In order to investigate the effects of fear reactivation during reinstatement testing on valence and arousal ratings, repeated measures ANOVAs with Time (t2 vs. t6) and Condition were performed. A significant Time x Condition interaction suggested that groups differed with respect to change in CS+ arousal from post-film to the end of the experiment. Post-hoc ANOVAs for each condition showed that CS+ arousal decreased in ImRs, $F(1, 37) = 15.33$, $p = < .001$, $\eta_p^2 = 0.29$, whereas it remained relatively stable over time in IRE, $F(1, 37) = 0.44$, $p = .511$, $\eta_p^2 = 0.01$, and NIC, $F(1, 38) = 1.00$, $p = .324$, $\eta_p^2 = 0.03$. No significant group differences could be observed for any other SAM item (i.e., CS+ valence, CS- valence, and CS- arousal), all *F*s < 1.36, all *p*s > .261, all η_p^2s < .02, indicating that even though the CS+ valence

ratings did not differ across conditions, only ImRs effectively reduced the subjective arousal elicited by the CS+.

Fear-Potentiated Startle

The test statistics for fear-potentiated startle (FPS) are summarized in Table 1 (a) to (f). The investigation of the fear-conditioning procedure (b) revealed that fear acquisition on Day 1 was successful as indicated by a significant main effect of Stimulus (CS+ vs. CS-; Figure 2). Retention of the learned fear memory from Day 1 to Day 2 was reflected by a significant main effect of Trial (c) with an increase in FPS in response to the CS+. A nonsignificant Stimulus x Trial x Condition interaction from acquisition (mean across all trials) on Day 1 to reactivation on Day 2 (c) and a nonsignificant Stimulus x Condition interaction at reactivation on Day 2 (d) suggested that groups did not differ regarding the retention of the previously learned fear association. Thus, after successful fear acquisition on Day 1, the fear memory was successfully consolidated in all conditions.

The investigation of the memory transfer from Day 1 to Day 3 (e) revealed a significant Stimulus x Trial interaction from acquisition to the first trial of the test phase on Day 3 indicating differences in FPS response on CS+ and CS- from pre- to post-intervention. Post-hoc tests showed that FPS to the CS+ remained relatively stable over time, $F(1, 114) = 0.05$, $p = .816$, $\eta_p^2 < 0.01$, whereas FPS to the CS- increased, $F(1, 114) = 9.43$, $p = .003$, $\eta_p^2 = 0.08$.

Surprisingly, fear reinstatement testing on Day 3 (f) did not reveal any significant main effect or interaction. Contrary to the hypothesis, the interventions did not differentially affect fear reinstatement from test 1 to test 2.

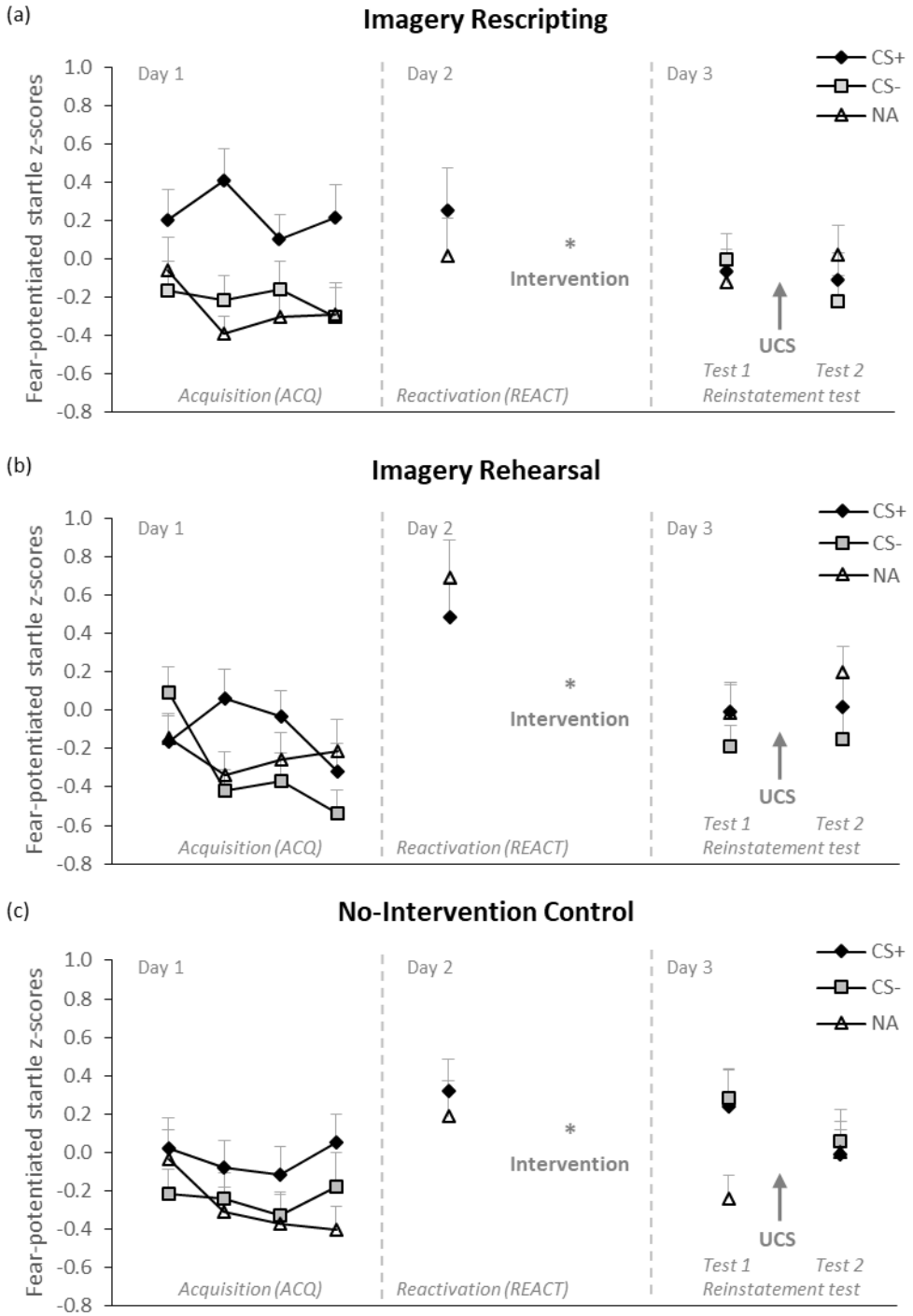

Figure 2. Mean fear-potentiated startle responses to CS+, CS-, and NA for (a) imagery rescripting, (b) imagery rehearsal, and (c) no-intervention control. Error bars represent standard errors of the mean.

Table 1. Mixed repeated-measures ANOVA with between-subject factor Condition (ImRs vs. IRE vs. NIC) and within-subject factors Stimulus and Trial for fear-potentiated startle

	F	*df*	*p*	η^2
(a) Baseline: Cs+ vs. CS-				
Stimulus	0.74	1, 112	.393	0.01
Stimulus x Condition	1.01	2, 112	.369	0.02
Condition	0.03	2, 112	.966	<0.01
(b) Acquisition (ACQ1 vs. ACQ4): CS+ vs. CS-				
Stimulus	6.36	1, 112	**.013**	0.05
Stimulus x Condition	2.31	2, 112	.104	0.04
Trial	2.34	1, 112	.129	0.02
Trial x Condition	1.97	2, 112	.144	0.03
Stimulus x Trial	1.67	1, 112	.198	0.02
Stimulus x Trial x Condition	0.81	2, 112	.450	0.01
Condition	2.28	2, 112	.107	0.04
(c) Retention (ACQ_mean vs. REACT): CS+ vs. NA				
Stimulus	4.16	1, 112	.044	0.04
Stimulus x Condition	1.87	2, 112	.158	0.03
Trial	23.50	1, 112	**<.001**	0.17
Trial x Condition	3.84	2, 112	.024	0.06
Stimulus x Trial	2.12	1, 112	.149	0.02
Stimulus x Trial x Condition	0.15	2, 112	.859	<0.01
Condition	1.58	2, 112	.210	0.03
(d) Reactivation (REACT): CS+ vs. NA				
Stimulus	0.14	1, 112	.705	<0.01
Stimulus x Condition	0.77	2, 112	.467	0.01
Condition	2.80	2, 112	.065	0.05
(e) Transfer (ACQ_mean vs. Test1): CS+ vs. CS-				
Stimulus	7.89	1, 112	.006	0.07
Stimulus x Condition	0.44	2, 112	.645	0.01
Trial	3.46	1, 112	.066	0.03
Trial x Condition	2.61	2, 112	.078	0.04
Stimulus x Trial	4.24	1, 112	**.042**	0.04
Stimulus x Trial x Condition	1.20	2, 112	.306	0.02
Condition	3.99	2, 112	.021	0.07
(f) Reinstatement (Test1 vs. Test2): CS+ vs. CS-				
Stimulus	0.36	1, 112	.550	<0.01
Stimulus x Condition	0.67	2, 112	.515	0.01
Trial	1.42	1, 112	.235	0.01
Trial x Condition	0.73	2, 112	.484	0.01
Stimulus x Trial	0.07	1, 112	.796	<0.01
Stimulus x Trial x Condition	0.15	2, 112	.860	<0.01
Condition	2.75	2, 112	.068	0.05

Note. Significant *p*-values relevant for the interpretation of the results are marked bold.

Skin Conductance Response

The test statistics for skin conductance responses (SCR) are summarized in Table 2 (a) to (f). The investigation of the conditioning procedure (b) revealed a significant main effect of Stimulus (CS+ vs. CS-) indicating successful, non-differential fear acquisition on Day 1 (Figure 3). Significant main effects of Stimulus (CS+ vs. NA) and Trial (c) indicated that fear learning was successfully transferred from Day 1 to Day 2 as shown by an increase in SCR from acquisition on Day 1 to reactivation on Day 2. No differences between groups could be detected with regard to SCR from acquisition to reactivation, which suggests successful memory consolidation in all conditions. Thus, SCR data paralleled FPS data showing successful memory consolidation after fear acquisition.

With respect to transfer of the acquired fear memory from acquisition on Day 1 to the first trial of the test phase on Day 3 (e), repeated measures ANOVA revealed only significant main effects of Stimulus (CS+ vs. CS-) and Trial, but no significant interaction, indicating that the interventions did not differentially affect memory transfer from Day 1 to Day 3.

Fear reinstatement test on Day 3 (f) yielded a significant Stimulus x Trial x Condition interaction. Contrary to the hypothesis, post-hoc test revealed that SCR towards the CS+ significantly decreased in IRE (p = .004), whereas it did not significantly change in ImRs (p = .279) or NIC (p = .070) from test 1 to test 2 of the reinstatement test. In ImRs, the SCR towards the CS- significantly decreased (p < .001) from Test 1 to Test 2, whereas it remained relatively stable in IRE (p = .696) and NIC (p = .227).

Online Distress

The results for online distress are summarized in Table 3 (a) to (c). Successful fear learning could be detected on online distress ratings by a significant Stimulus x Trial interaction (a) (Figure 4). Online distress in response to the CS+ decreased from acquisition on Day 1 to the first trial of the testing phase on Day 3 as demonstrated by a significant Stimulus x Trial interaction (b). Surprisingly, no significant differences between conditions could be detected regarding memory transfer from Day 1 to Day 3.

The reinstatement test on Day 3 (c) revealed a significant Stimulus x Trial interaction indicating differential fear reinstatement from test 1 to test 2 with a stronger increase in response to the CS+ when compared to the CS-. Contrary to expectations, no significant interaction with condition could be detected.

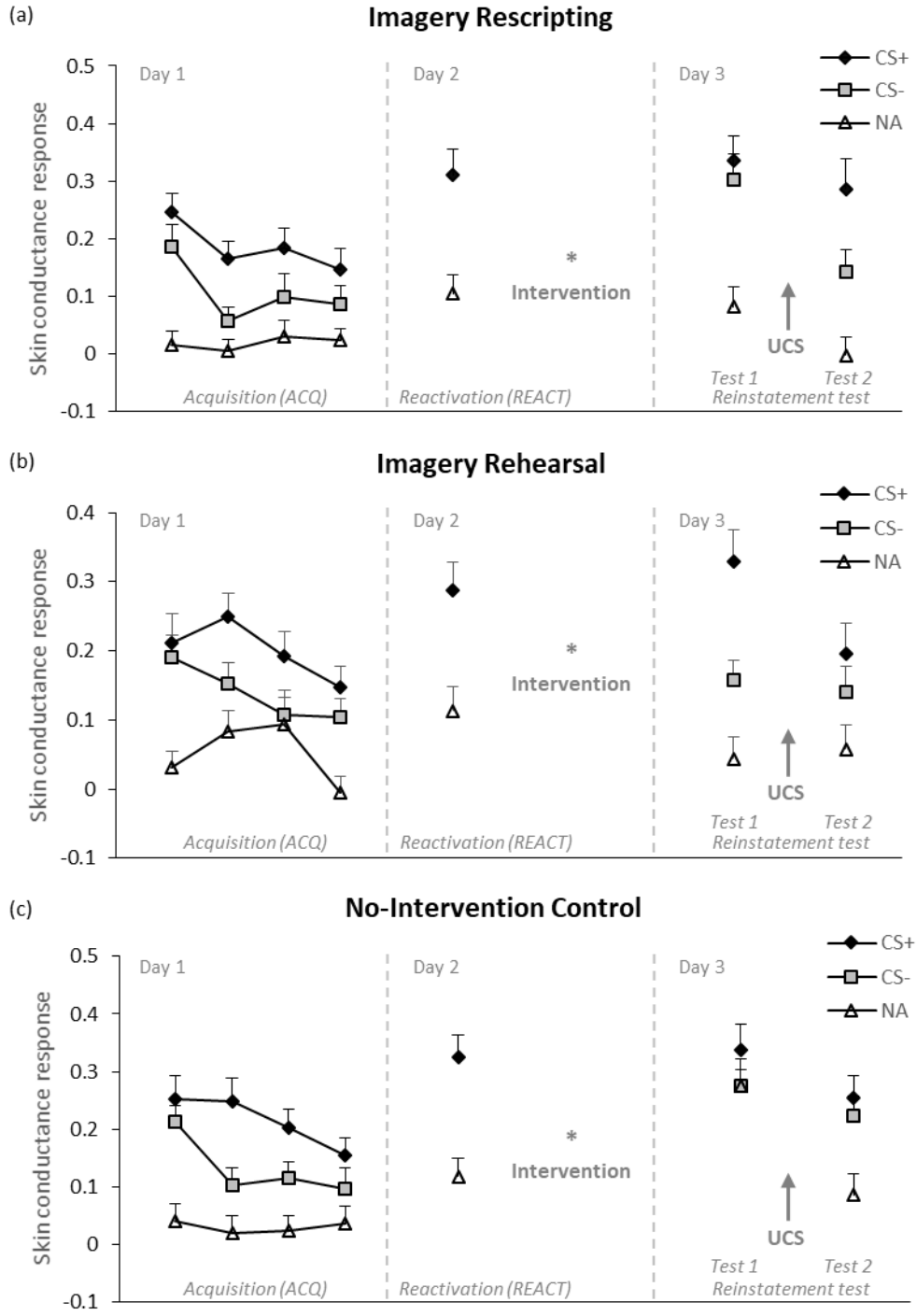

Figure 3. Mean skin conductance responses to CS+, CS-, and NA for (a) imagery rescripting, (b) imagery rehearsal, and (c) no-intervention control. Error bars represent standard errors of the mean.

Table 2. Mixed repeated-measures ANOVA with between-subjects factor Condition (ImRs vs. IRE vs. NIC) and within-subject factors Stimulus and Trial for skin conductance response.

	F	*df*	*p*	η^2
(a) Baseline: Cs+ vs. CS-				
Stimulus	0.60	1, 112	.442	0.01
Stimulus x Condition	0.74	2, 112	.480	0.01
Condition	0.65	2, 112	.524	0.01
(b) Acquisition (ACQ1 vs. ACQ4): CS+ vs. CS-				
Stimulus	5.43	1, 112	**.022**	0.05
Stimulus x Condition	0.15	2, 112	.862	<0.01
Trial	28.35	1, 112	<.001	0.20
Trial x Condition	0.30	2, 112	.742	0.01
Stimulus x Trial	0.22	1, 112	.640	<0.01
Stimulus x Trial x Condition	0.05	2, 112	.949	<0.01
Condition	0.15	2, 112	.863	<0.01
(c) Retention (ACQ_mean vs. REACT): CS+ vs. NA				
Stimulus	127.57	1, 112	**<.001**	0.53
Stimulus x Condition	0.40	2, 112	.674	0.01
Trial	26.20	1, 112	**<.001**	0.19
Trial x Condition	0.25	2, 112	.781	<.0.01
Stimulus x Trial	0.98	1, 112	.323	0.01
Stimulus x Trial x Condition	0.03	2, 112	.970	<0.01
Condition	0.23	2, 112	.798	<0.01
(d) Reactivation (REACT): CS+ vs. NA				
Stimulus	53.52	1, 112	<.001	0.32
Stimulus x Condition	0.16	2, 112	.852	<0.01
Condition	0.13	2, 112	.878	<0.01
(e) Transfer (ACQ_mean vs. Test1): CS+ vs. CS-				
Stimulus	26.01	1, 112	**<.001**	0.19
Stimulus x Condition	1.30	2, 112	.276	0.02
Trial	41.29	1, 112	**<.001**	0.27
Trial x Condition	2.14	2, 112	.122	0.04
Stimulus x Trial	0.22	1, 112	.644	<0.01
Stimulus x Trial x Condition	2.32	2, 112	.103	0.04
Condition	0.60	2, 112	.553	0.01
(f) Reinstatement (Test1 vs. Test2): CS+ vs. CS-				
Stimulus	19.50	1, 112	<.001	0.15
Stimulus x Condition	1.11	2, 112	.334	0.02
Trial	22.24	1, 112	<.001	0.17
Trial x Condition	0.45	2, 112	.642	0.01
Stimulus x Trial	0.10	1, 112	.758	<0.01
Stimulus x Trial x Condition	3.14	2, 112	**.047**	0.05
Condition	1.37	2, 112	.258	0.02

Note. Significant *p*-values relevant for the interpretation of the results are marked bold.

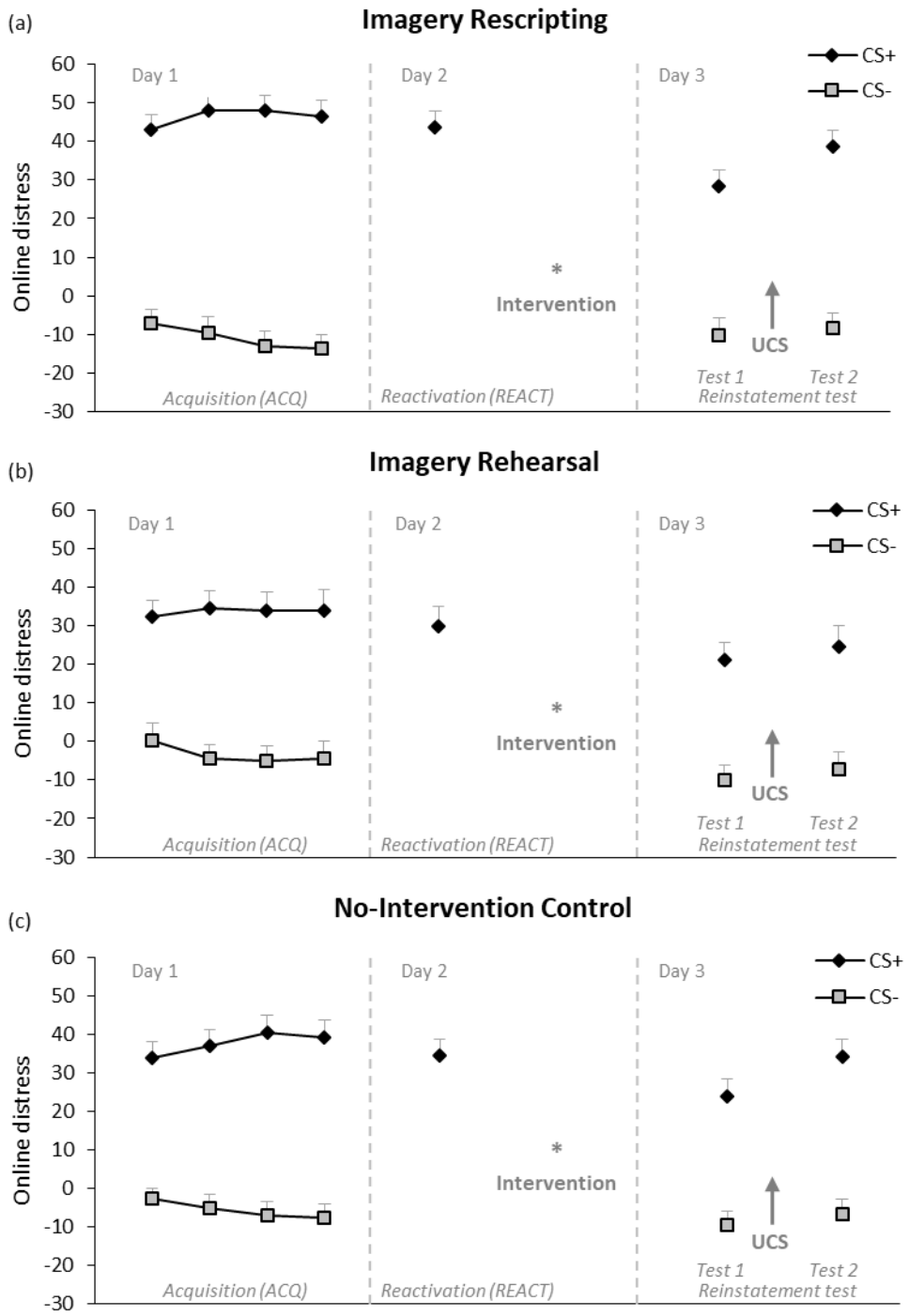

Figure 4. Mean online distress ratings controlled for baseline scores for CS+ and CS- for (a) imagery rescripting, (b) imagery rehearsal, and (c) no-intervention control. Error bars represent standard errors of the mean.

Table 3. Mixed repeated-measures ANOVA with between-subjects factor Condition (ImRs vs. IRE vs. NIC) and within-subject factors Stimulus and Trial for online distress ratings.

	F	*df*	*p*	η^2
(a) Acquisition (ACQ1 vs. ACQ4): CS+ vs. CS-				
Stimulus	149.60	1, 111	<.001	0.57
Stimulus x Condition	2.58	2, 111	.080	0.04
Trial	1.18	1, 111	.279	0.01
Trial x Condition	0.53	2, 111	.588	0.01
Stimulus x Trial	25.41	1, 111	**<.001**	0.19
Stimulus x Trial x Condition	0.56	2, 111	.572	0.01
Condition	0.13	2, 111	.882	<0.01
(b) Transfer (ACQ_mean vs. Test1): CS+ vs. CS-				
Stimulus	144.13	1, 111	<.001	0.57
Stimulus x Condition	1.45	2, 111	.239	0.03
Trial	52.22	1, 111	<.001	0.32
Trial x Condition	0.06	2, 111	.941	<0.01
Stimulus x Trial	27.92	1, 111	**<.001**	0.20
Stimulus x Trial x Condition	2.88	2, 111	.060	0.05
Condition	0.40	2, 111	.669	0.01
(c) Reinstatement (Test1 vs. Test2): CS+ vs. CS-				
Stimulus	111.86	1, 111	<.001	0.50
Stimulus x Condition	0.85	2, 111	.430	0.02
Trial	40.87	1, 111	<.001	0.27
Trial x Condition	1.49	2, 111	.229	0.03
Stimulus x Trial	12.91	1, 111	**<.001**	0.10
Stimulus x Trial x Condition	2.56	2, 111	.082	<0.01
Condition	0.79	2, 111	.454	0.01

Note. Significant *p*-values relevant for the interpretation of the results are marked bold.

Discussion

The present study investigated the effects of imagery rescripting (ImRs) compared to exposure-based imagery rehearsal (IRE) and a no-intervention control condition (NIC) on memory reconsolidation following an analogue trauma induction in a healthy sample. For this purpose, a three-day fear-conditioning paradigm was used. To model complex associative fear memories, a distressing memory was induced by an aversive trauma film and subsequent fear-conditioning using stimuli from the aversive film. To allow for memory consolidation and reconsolidation to occur, the analogue interventions (i.e., ImRs, IRE, or NIC) were administered one day after memory induction (Day 2). Return of fear was investigated by UCS reinstatement testing on Day 3 of the experiment. Objective (fear-potentiated startle [FPS], skin conductance response [SCR]) and subjective measures (mood, distress, valence, and arousal) were used to assess emotional responding across all phases of the experiment.

Successful fear learning on Day 1 of the experiment could be observed on subjective and objective measures. Subjective responding to the fear-conditioning procedure was differential for the CSs, whereas psychophysiological fear-learning was non-differential. Unlike traditional fear-conditioning paradigms, participants in the present study were presented with an aversive film before the differential fear-learning procedure and were instructed about the CS-UCS contingency beforehand. Thus, participants were likely aware of the CS-UCS association after watching the aversive film (see also, Kunze et al., 2015, 2019). The subsequent fear acquisition did therefore not induce, but rather enforce the previously learned fear association. Similar fear acquisition patterns have been found in previous studies using aversive film material as conditioning stimuli (Kunze et al., 2019; Landkroon, Mertens, Sevenster, Dibbets, & Engelhard, 2019). Subsequently, the fear memory was successfully consolidated in all conditions as indicated by successful retention of the physiological fear response from Day 1 to Day 2. Contrary to the expectations, the interventions did not have significantly different effects on the transfer of the learned fear response to the CS+ on subjective (distress) or objective measures (FPS, SCR) from acquisition on Day 1 to reinstatement testing on Day 3.

With respect to the primary hypothesis, return of fear towards the CS+ after UCS reinstatement could only be observed on subjective online distress and groups did not differ. In contrast to the hypothesis, no return of fear could be detected on mood ratings or FPS in any of the conditions. Surprisingly, emotional responding on SCR towards the CS+ even decreased in IRE. In ImRs, the SCR towards the CS+ remained relatively stable, whereas the response to the CS- decreased. Thus, the fear response became even more differential in ImRs, possibly because the CS- was experienced as even safer after UCS presentation.

Several interpretations of this unexpected pattern of results are possible. On the one hand, the findings might indicate that not only the active treatment conditions, but also NIC prevented a return of fear on psychophysiological measures at UCS reinstatement testing. This interpretation would lead us to conclude that ImRs and IRE did not have any additional effect to no-intervention after consolidation of the conditioned fear response. Furthermore, subjective online distress might rather reflect a cognitive component of the fear response such as awareness of the CS-UCS contingency (Kunze et al., 2019), whereas FPS is assumed to be associated with the emotional component of fear irrespective of cognitive knowledge. While all conditions appeared to prevent a return of fear regarding the emotional component of the fear response (FPS), participants were still cognitively aware that the CS+ was the threatening stimulus as indicated by the increase in subjective distress after the unexpected UCS presentation. Future studies should follow up on these results and further investigate the effects

of the interventions on different components of fear responding (emotional vs. cognitive) towards conditioned stimuli.

On the other hand, it also seems plausible that differences between conditions regarding return of fear could not be detected due to procedural limitations of the study. First, as fear-learning during acquisition was non-differential, it could be argued that the UCS was not a proper stimulus to test fear reinstatement. Participants had already learned that the CS+ was threatening by watching the aversive film and the presentation of the UCS during the conditioning procedure did not have any additional impact on this fear association. It remains unclear whether participants' fear reaction was actually linked to the film clip used as the UCS or to another scene/image from the aversive film. If the fear reaction was indeed associated with another, individual hotspot, the UCS might not have been a sufficient stimulus to test reinstatement. Correspondingly, previous research suggests that ImRs is most effective if the individual hotspot is included (Dibbets & Arntz, 2016). Thus, using a standardized UCS during acquisition and ImRs might have reduced the effectiveness of the fear-learning procedure and the intervention in this study, respectively. Future research should individualize fear acquisition, reinstatement testing, as well as the interventions by using individual hotspots as UCS. Second, as already discussed by Kunze et al. (2019), the two-phase fear-learning procedure of the current paradigm with the presentation of the aversive film and the subsequent fear-conditioning might unintentionally have induced two different fear memories. Even though we improved previous study designs by ensuring that the interventions explicitly addressed the conditioning stimuli, we cannot rule out that the verbal interventions may have targeted only one memory (i.e., film-induced memory), whereas physiological outcomes may rather have measured responding to the other memory (i.e., fear-conditioning memory). Thus, physiological measures might not have been valid instruments to test changes in the mental representation of the aversive film. In line with this idea, intervention effects were evident on subjective outcomes that may reflect changes in responding to the film-induced memory. Whereas negative affect increased from pre- to post-intervention in both conditions, ImRs and IRE differed regarding positive affect with participants in ImRs reporting more positive affect post-intervention when compared to IRE. A similar effect has been found in previous studies (e.g., Cili, Pettit, & Stopa, 2017; Kunze et al., 2019). In order to improve the current paradigm, future research should investigate whether the current procedure induces two different memories, for example by systematically comparing memory induction via aversive film presentation with and without subsequent fear-conditioning.

The following limitations should be considered when interpreting the present findings.

Several procedural concerns with regard to the validity of the current paradigm have already been discussed above. The conditions used in the present study account for additional limitations. First, NIC might not be a proper control condition, as we do not know what exactly happens during the break. It seems plausible that participants may have used personal coping strategies (e.g., spontaneous engagement in mentally rehearsal; Ball & Brewin, 2012; James, Lau-Zhu, Clark, Visser, Hagenaars, & Holmes, 2016) after memory reactivation on Day 2, which might confound the results by reducing differences between the experimental and the control conditions. Second, ImRs and IRE deviated from imagery- and exposure-based interventions used in clinical practice. In clinical practice, the duration of the interventions depends on the patients' individual needs, whereas in experimental studies interventions need to be standardized in order to improve comparability. However, this standardization might have reduced the power of the interventions in the present study. Additionally, the induced fear memory in trauma film studies lacks personal relevance for participants, thus reducing generalizability of the results to clinical settings (for a discussion, see James et al., 2016).

The present study was among the first three-day experimental studies that aimed to systematically investigate the effects of ImRs as a means to disrupt memory reconsolidation when compared to an exposure-based IRE and a no-intervention control condition. Contrary to the expectations, a return of fear could only be detected on subjective distress, but not on psychophysiological measures and no differences between the conditions could be observed. Thus, conclusions about the mechanisms underlying ImRs cannot be drawn from the present results as to whether ImRs works though changing the meaning of the original aversive memory or whether it may facilitate the formation of an inhibitory memory trace. As the combination of a trauma film with an associative fear learning paradigm seems to successfully induce complex fear memories (e.g., Dibbets et al., 2018; Kunze et al., 2015), it might facilitate a better understanding of memory mechanisms underlying psychological treatments. However, in the present study, this investigative approach appears to be limited in its ability to model treatment effects in an analogue setting (see also, Kunze et al., 2019). In order to be able to systematically investigate the effects and working mechanisms underlying complex therapeutic interventions in the laboratory, future research is needed to further develop and improve the existing experimental paradigms.

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Study III

Improving Imagery Rescripting Treatments: Comparing an Active versus Passive Approach

Abstract

Background and objectives: In imagery rescripting (ImRs), aversive mental images are modified to reduce symptoms in a variety of psychological disorders. However, uniform guidelines on how to optimally implement ImRs do currently not exist. It remains unclear whether therapists should stimulate patients to imagine themselves to actively intervene within the new image, or whether they may imagine helpers to change the situation. We aimed to compare these two variants of ImRs within an analogue experimental setting.

Methods: After having watched an aversive film, one-hundred participants were randomly assigned to active ImRs (ImRs-A), passive ImRs (ImRs-P), imagery rehearsal (IRE), or no-intervention control (NIC). Participants were either instructed to rescript the film by imagining themselves intervening in the new script (ImRs-A) or encouraged to imagine helpers to intervene in the imagined situation (ImRs-P).

Results: Both ImRs increased mastery and elicited less distress than IRE with ImRs-P being experienced as less distressing than ImRs-A. Only ImRs-A led to a stronger increase in positive affect than IRE, whereas groups did not differ with respect to negative affect and self-efficacy. Conditions did not differ regarding the number of film-related intrusive memories.

Limitations: As a convenience sample was investigated, results cannot be generalized to clinical samples.

Conclusion: Even though differences regarding symptomatic outcome could not be detected, ImRs-P was experienced as less distressing than ImRs-A. Results suggest that both ImRs lead to different processes during the intervention than mere exposure. Compared to IRE, ImRs increases mastery with ImRs-A and ImRs-P being equally effective.

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General Discussion

This thesis aimed to investigate effects of and potential working mechanisms underlying imagery rescripting (ImRs) for distressing memories after an analogue trauma induction in healthy samples. Using a multiple-day trauma film paradigm (TFP), **Studies I** and **II** aimed to extend previous research on ImRs (e.g., Hagenaars & Arntz, 2012; Kunze et al., 2015, 2019) by examining the effects of ImRs on memory reconsolidation of consolidated memories. **Study I** focused on the investigation of therapeutic effects of ImRs on artificially induced intrusive re-experiencing and emotional responding, whereas **Study II** combined the TFP with a fear-conditioning paradigm in order to further examine treatment effects on reconsolidation processes and to extend findings onto psychophysiological measures. **Study III** aimed to systematically investigate different variations of ImRs and associated working mechanisms by examining the effectiveness of two ImRs protocols (active vs. passive ImRs) and the role of mastery and self-efficacy as potential working mechanisms underlying these ImRs interventions. In all three studies, ImRs was tested against exposure-based imagery rehearsal (IRE) as an active control condition and a no-intervention control condition (NIC). In the following sections, the main findings of **Studies I, II,** and **III** are summarized and implications for future research are discussed.

Summary of Findings

Effects of ImRs on Artificially Induced Distressing Memories after Memory Consolidation (Studies I and II)

Studies I and **II** were based on previous experimental research using the TFP to investigate the effects of ImRs (e.g., Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012; Seebauer et al., 2014). Whereas previous studies mainly focused on the preventive effects of ImRs on memory encoding and/or consolidation, **Studies I** and **II** examined the clinically more relevant therapeutic effects of ImRs with respect to already consolidated memories. For this purpose, **Study I** used an adapted multiple-day TFP within which participants received the intervention 24 h after memory induction, thereby allowing for memory consolidation prior to treatment. **Study II** further improved this paradigm by combining the multiple-day TFP with a fear-conditioning procedure, which enables the assessment of not only subjective but also objective (i.e., psychophysiological) measures. Both studies were based on the idea suggested by Arntz (2012) that ImRs for trauma-related disorders might work by changing the dysfunctional meaning of the memory representation of the aversive event during memory recall, a process which is referred to as memory revaluation. Whereas **Study I** aimed at testing

the adapted multiple-day TFP and primarily focused on the investigation of the short- and longer-term effects of ImRs on emotional responding and intrusive re-experiencing, **Study II** was explicitly designed to study memory updating processes during reconsolidation. In **Study I**, ImRs was experienced as less distressing and was associated with less negative emotional responding when compared to IRE suggesting that by changing meaning-relevant content, ImRs might be emotionally less stressful than exposure-based interventions. These findings support the assumption that ImRs is a promising treatment alternative to state-of-the-art exposure-based therapies that might be better accepted by patients. Even though previous research showing a superiority of ImRs in reducing the total number of intrusions (Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012) could not be replicated in **Study I,** ImRs accelerated the decline of intrusive memories over time indicating faster symptom recovery. However, the latter result can only be interpreted cautiously as artificially induced intrusive memories appeared to naturally decline quickly. Even though the multiple-day TFP as used in **Study I** is assumed to tap into memory updating processes, **Study I** was not able to specifically test the memory revaluation hypothesis as suggested by Arntz (2012). Thus, **Study II** was conducted to provide empirical evidence that might shed light on memory reconsolidation processes during ImRs. The hypothesis that ImRs works by changing the dysfunctional meaning of the original memory representation of the aversive event (Arntz, 2012) was tested within a three-day fear-conditioning procedure that was combined with the TFP as a means to create a relevant context between the conditioning stimuli (Kunze et al., 2015). It was expected that only ImRs would prevent a return of the fear response after reconsolidation of the memory which was modified during treatment. Unexpectedly, none of the conditions showed a return of fear on physiological measures, not even NIC. Return of fear could only be detected on subjective distress ratings in all conditions. Thus, from **Study II**, no conclusions could be drawn about the memory mechanisms that may underlie ImRs treatment. On the one hand, this null finding on psychophysiological measures may be explained by the assumption that also the NIC condition was an effective treatment (e.g., by mere attention by the experimenter). On the other hand, procedural limitations of the paradigm may account for the unexpected results. It seems possible that the standardized stimulus, which was supposed to provoke the return of the fear response, was not valid for this purpose, as it was not individualized. Additionally, two different memories may have been induced during memory induction and the physiological measures may not have been valid instruments to test changes in the film-induced memory that was modified during ImRs, but may rather have assessed the responding to the fear-conditioning-induced memory that was not explicitly targeted during treatment.

Taken together, the experimental paradigms used in **Studies I** and **II** elicited analogue posttraumatic reactions and symptoms such as distress, negative emotions, and intrusive memories. After successful memory induction and consolidation, positive effects of ImRs on process variables such as emotional responding and distress as well as faster symptom recovery could be observed (**Study I**). However, treatment effects on outcome variables (i.e., amount of intrusive memories, return of fear) could not be detected. The investigation of these effects was likely impeded by procedural limitations of the paradigms (e.g., floor effect of intrusive memories [**Study I**], invalidity of stimuli and measures [**Study II**]).

Investigation of Different ImRs Approaches: Comparison of Active vs. Passive ImRs and the Role of Mastery and Self-Efficacy (Study III)

Study III was designed to investigate the efficacy of two different ImRs approaches and potentially associated working mechanisms. So far, ImRs is applied using different procedures by both clinicians and researchers (Arntz, 2012) and research into variations of ImRs is scarce. This observation is highly problematic as it comprises the comparability of findings on the efficacy and potential working mechanism of ImRs. In order to improve our understanding of how ImRs works best and which processes may underlie effective treatment, research into the different variants of ImRs is clearly needed. Therefore, **Study III** focused on the investigation of two different ImRs approaches, namely active vs. passive ImRs. The approaches differed content-wise with respect to the role the participants played in the newly developed script (actively acting vs. passively observing others acting). Additionally, based on (social) cognitive theories of PTSD (e.g., Ehlers & Clark, 2000; Foa & Rothbaum, 1998; Benight & Bandura, 2004) and preliminary findings on ImRs for nightmare disorder (Kunze et al., 2019), mastery and self-efficacy as working mechanisms potentially underlying ImRs were examined. Given that **Study III** was the first study to systematically compare active vs. passive ImRs, the effectiveness of the interventions on memory consolidation was investigated as a first step. For this purpose, an distressing memory was induced by means of an aversive film and the ImRs interventions were conducted briefly after memory induction. Unexpectedly, previous findings on the preventive effects of ImRs on intrusive memory development (Hagenaars & Arntz, 2012) could not be replicated in **Study III**. However, results pointed towards a non-significant trend that active ImRs might accelerate the decrease of film-induced intrusive memories, paralleling the findings of **Study I**. In line with findings from **Study I** and earlier research, in **Study III**, both ImRs variants were experienced as less distressing when compared to an exposure-based

intervention, indicating that ImRs might be a more tolerable treatment alternative. Interestingly, passive ImRs was experienced as even less distressing than active ImRs. Furthermore, both ImRs variants increased feelings of mastery when compared to exposure-based IRE, but did not increase self-efficacy. Although active ImRs was expected to facilitate an even stronger increase in mastery than passive ImRs, the two approaches did not differ. Thus, the different variants may have promoted feelings of mastery by different mechanisms: Whereas active ImRs may have directly enhanced mastery by expressing inhibited action tendencies, passive ImRs may have indirectly facilitated the experience of mastery by observational learning (Bandura, 1999). Results indicate that even though a short ImRs intervention may facilitate the experience of mastery, it may not be sufficient to increase self-efficacy, which is more related to the concept of one's self and therefore possibly less prone to modifications by brief interventions.

Taken together, the increase in feelings of mastery in both ImRs conditions suggests that during ImRs the meaning of the aversive memory was changed and thus supports Arntz' revaluation hypothesis (2012). However, this interpretation is limited by the fact that the effectiveness of the ImRs protocols used in **Study III** with respect to treatment outcome (i.e., intrusive memories) could not be demonstrated. Similar to **Studies I** and **II,** the experimental research design based on the TFP once more appeared to be limited in its ability to model treatment effects of complex psychological techniques in an analogue setting.

Implications for Future Research

Improving Experimental Paradigms

The experimental studies presented in this thesis used the TFP as an analogue to model the effects and working mechanisms of ImRs for distressing memories. By ensuring high experimental control over the symptom-eliciting stressor, the TFP provides a good laboratory analogue for traumatic experiences (for reviews see, Arnoudova & Hagenaars, 2017; Holmes & Bourne, 2008; Weidmann, et al., 2009). In **Study II,** the TFP was combined with a fear-conditioning procedure, allowing to further investigate treatment effects on memory reconsolidation processes. Both the TFP and fear-conditioning procedures have widely been used in experimental research (Beckers, Krypotos, Boddez, Effting, & Kindt, 2013; Holmes & Bourne, 2008; James et al., 2016; LeDoux, 2014; Lonsdorf et al., 2017). Laboratory manipulations of traumatic experiences and interventions in analogue studies have several advantages over clinical research in patient populations, e.g., they enable researchers to systematically investigate causal relationships between variables. Moreover, a major problem

of clinical research in patient samples is the third variable problem, i.e., changes in the dependent variables of interest may be caused by several unknown variables (Van den Hout et al., 2017). Analogue studies can help reducing the third variable problem by allowing for manipulation of the variables of interest under well-controlled conditions in non-clinical samples. Using non-clinical samples enables us to isolate specific variables of interest and to control for other, potentially interfering variables. However, besides the methodological advantages of experimental analogue research, the studies presented in this thesis revealed several limitations of the paradigms that should be considered in future research. The results of the present thesis indicate that even though the experimental paradigms are valuable to investigate process variables (i.e., memory mechanisms, changes in emotionality/distress/mastery) and therefore may facilitate a better understanding of ImRs treatments, the suitability to test effects on treatment outcome (i.e., intrusive memories, relapse) is limited.

One major limitation of the present studies was the observation that experimentally induced intrusive memories seem to decline quickly even without conducting an intervention (**Studies I** and **III**). This might cause a floor effect of intrusive memories, thereby impeding the examination of symptomatic change. However, modeling symptomatic change in experimental analogue research constitutes a necessary requirement for the investigation of causal relationships between process and outcome variables that in turn may improve our understanding of working mechanisms potentially underlying psychological treatments (Kazdin, 2007). Future research is recommended – after ethical considerations – to use different aversive films (e.g., real-life footage of traumatic events) that might increase film-induced symptomatology.

Another limitation of the TFP that could also explain the difficulties in inducing significant levels of short-lived symptomatology may be the lack of personal relevance of aversive films for participants. However, given that ImRs commonly not only focuses on rescripting of the sequence of events of the distressing memory into a more benign outcome, but also aims at creating more positive images of the self (e.g., with respect to personal competences), personal relevance of the distressing memory seems important (Holmes et al, 2007; Stopa, 2009). This assumption is paralleled by the findings of **Study III** showing that the analogue ImRs interventions were not able to facilitate an increase in self-efficacy which is strongly related to the concept of one's self. In a similar vein, ImRs is assumed to work best if the individual hotspot (i.e., the most aversive part of the memory) is included during the rescripting (Dibbets & Arntz, 2016). However, in **Study III**, standardized stimuli deriving from

the aversive film were used as conditioning stimuli within the fear-conditioning procedure (i.e., scream as UCS and perpetrator as CS), thereby not explicitly considering individual hotspots. Thus, using standardized stimuli during fear-conditioning and ImRs may have impeded the effectiveness of the fear-learning procedure and the intervention. It is conceivable that the participants' fear reactions have been linked to other stimuli deriving from the aversive film than the ones used as UCS and CS, thereby reducing the ability of the UCS to evoke a return of fear and consequently making it impossible to detect treatment effects. Future research is recommended to increase personal relevance by modifying the experimental paradigm used in **Study III**: Fear-learning, interventions, and fear reinstatement testing should be individualized by assessing individual hotspots and subsequently personalizing stimuli based on the hotspots (i.e., choosing UCS and CS that represent the individual hotspot). For future research, personal relevance could also be increased by using different experimental paradigms: Participants could more personally be involved in the distressing events of an aversive film, for example by using virtual reality (VR) techniques. Within VR, personal relevance and eventually experimentally induced symptoms could be enhanced by actively involving participants in a virtual environment instead of just letting them passively observe (Dibbets & Schulte-Ostermann, 2015). It should be noted that a first study comparing the TFP to VR did not support the proposition, that VR is more effective than the TFP in inducing analogue posttraumatic symptoms (Dibbets & Schulte-Ostermann, 2015). However, the interpretation of the findings of this study are limited by the fact that the aversive events presented with the TFP differed from the ones presented in VR. Thus, in order to improve experimental paradigms, it might be worthwhile to compare VR to the TFP by presenting the same aversive events in the different modalities. Alternatively, in order to improve personal relevance of the aversive memory, ImRs could be investigated in healthy samples with distressing autobiographical memories or in sub-clinical samples (see also, Strohm et al., 2019).

Even though the primary aim of experimental analogue studies is not to directly transfer findings to clinical contexts, but rather to study hypotheses about causality and to investigate processes that are involved in the development or maintenance of symptoms (e.g., Forsyth & Zvolensky, 2002; Van den Hout et al., 2017), it has repeatedly been criticized that findings cannot be generalized from convenience samples to patient populations. It is generally difficult to transfer complex clinical interventions to analogue experimental research designs. As stated by Van den Hout and colleagues (2017), "It rarely happens that insights from experimental psychology can *directly* be used to explain clinical phenomena" (p. 143). However, it is important to distinguish between applied clinical studies and experimental analogue research

as different approaches that address different research questions (see also e.g., Forsyth & Zvolensky, 2002; Van den Hout et al., 2017). In order to answer questions such as '*Does ImRs benefit patients with PTSD?'*, it is necessary to conduct applied clinical studies investigating treatment effects in patient samples (Van den Hout et al., 2017). However, if we want to explain *how* an intervention works and draw conclusions about causality, it seems necessary to experimentally investigate treatment variants and process variables within analogue studies. Doing so, the present thesis offers preliminary data on different ImRs approaches and processes that might be relevant during ImRs treatments. Even though the results from this thesis are based on healthy samples and thus, are limited in their generalizability to patient populations, this thesis contributes to the improvement of our general understanding of ImRs interventions.

Advancing Our Understanding of ImRs

To date, no uniform guidelines exist on how to optimally implement ImRs. As a consequence, both researchers and clinicians apply diverse techniques under the label *imagery rescripting*. Using the label ImRs for multiple types of treatment protocols is generally problematic and raises several empirical questions such as '*What kind of ImRs works best for whom and under which conditions?', 'Are different variants of ImRs similarly effective?'*. Addressing these research questions is a step-wise process that requires a series of different types of studies (i.e., experimental and applied clinical studies) that may improve our understanding of ImRs.

Study III of the present thesis can be regarded as a first step in systematically investigating two of the several existing ImRs procedures, namely active vs. passive ImRs. There is an ongoing discussion regarding the content of the newly developed script that is generated by the patients/participants (Arntz, 2012; Arntz & Weertman, 1999; Smucker et al., 1995). **Study III** addressed the empirical question whether patients/participants need to imagine playing an active role in the new script or whether they can also imagine themselves as passive bystanders observing others acting in the imagined situation. Findings suggest that both variants of ImRs (i.e., active and passive) are similarly effective in facilitating feelings of mastery. However, given that the research paradigm used in **Study III** was eventually impeded by a floor effect of intrusive memories and lacked personal relevance, future research on active and passive ImRs should use different paradigms with personally more relevant distressing memories (e.g., autobiographical memories) or investigate the effects with respect to different outcome measures (e.g., emotional response to reactivation, psychophysiological measures).

Even though the interventions applied in **Study III** differed regarding the participant's level of activity they played with respect to the content of the new script, participants in both conditions actively developed the new script. Thus, in both ImRs variants the participants were actively involved in the process of developing the new images and memories. This is in line with clinical practice in which ImRs is widely regarded as an active process of changing aversive images and memories. However, for severely distressed patients that do not feel powerful enough to imagine intervening in the new script, it has been suggested that the therapist might develop the new script (therapist-led approach; Arntz, 2012; Arntz & Weertman, 1999; Smucker et al., 1995). It remains an empirical question whether patients/participants need to actively develop the new script themselves (regardless of the content) or whether a therapist-led approach would be similarly effective.

Furthermore, inspection of the new scripts developed by participants in **Study III** revealed that most of the participants integrated both disempowerment of the perpetrator and soothing the victim in the new script, even though providing compassion to the victim was not explicitly requested. This observation is in line with ImRs interventions typically used in clinical practice. However, as the intervention protocols used in **Study III** did not explicitly distinguish between a 'disempowering' and a 'soothing' part and therefore, no time-frames were set for the different parts of ImRs, conclusions about distinct processes that occurred during the phases with respect to the dependent variables could not be drawn. In accordance with the idea that ImRs may work by enabling patients/participants to express action tendencies that were inhibited during the aversive event (Arntz, 2012), it is also conceivable that depending on the patient's/participant's individual needs, different actions during ImRs (e.g., disempowering the perpetrator, acting out aggression, providing compassion to the victim) may be necessary for different individuals. For example, after a single incident trauma, the primary goal of ImRs may be to reduce feelings of helplessness and increase feelings of mastery/self-efficacy by confronting the perpetrator, whereas for other patients (e.g., after interpersonal trauma), providing compassion to the victim may be crucial. In order to improve our understanding of which ImRs works best for whom, it would be interesting for future research to specifically study the role of different actions during ImRs following different types of traumatization, e.g., by investigating emotional experiences over the course of different phases of ImRs or by comparing disempowerment-focused ImRs to compassion-focused ImRs.

In the context of the idea that various ImRs approaches might be differently effective with respect to different types of traumatization, it should be noted that the TFP as used in the present thesis provides an analogue for witnessing a traumatic event rather than for first-person direct

exposure to such an event. Even though according to the DSM-5 A-criterion for PTSD (American Psychiatric Association, 2013) the definition of potential stressors leading to PTSD comprise different contexts of traumatic events (i.e., first-person direct exposure, witnessing, indirect exposure), it remains an empirical question whether findings from different contexts of traumatic events generalize to other contexts. Thus, future research should more specifically investigate differential effects of different ImRs approaches on posttraumatic symptomatology after first-person vs. witnessing vs. indirect exposure to the traumatic event. This could improve our understanding of which ImRs approach works best for specific contexts of traumatization.

The analogue ImRs interventions used in the present thesis deviated in certain aspects from protocols as commonly used in clinical practice. Based on the ImRs protocols originally developed for the treatment of childhood trauma (Arntz & Weertman, 1999), ImRs is typically conducted in three phases that include changes in perspective from the child's perspective to the adult's perspective and back (see General Introduction). However, according to Holmes and colleagues (2007), ImRs does not necessarily comprise a change in perspective, as the authors defined ImRs (or IR) as a technique "in which either (1) a preexisting negative mental image (IR ''Type A'') is transformed into a more benign image (i.e., negative image to positive image rescripting), or (2) a new positive image (IR ''Type B'') is constructed afresh to capture those positive meanings needed to counteract the key psychological concerns for a patient (i.e., using a fresh positive image to rescript negative schematic beliefs)" (p. 298). In line with previous experimental research (e.g., Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012; Kunze et al., 2019), the ImRs interventions used in the present thesis were adapted for the analogue setting and did not include different phases with change in perspective. Given that it has not systematically been studied whether treatment success depends on the change of perspective, this has to be considered an open empirical question. Future research should further investigate whether the rescripted scene needs to be experienced from different perspectives (child and adult) or whether rescripting the event to a more positive outcome without change in perspective – as done in the present thesis – may suffice.

Given that research into different variants of ImRs has just recently begun, a multitude of empirical questions – of which several have been discussed above in detail – is still unanswered and should be addressed in future research. Besides examining the questions '*How should ImRs formally be conducted in order to be most effective?*' and '*What aspects are important with respect to the content of the newly developed script?*', future research should also consider that different ImRs approaches may work through different mechanisms. By increasing our understanding of which ImRs approach works best for whom, under which condition(s), and

through which mechanism(s), more individualized ImRs treatments can be developed rather than a one-fits-all solution. Thus, a better understanding of which ImRs works best for whom and how ImRs facilitates change may improve treatment efficacy.

Working Mechanisms Potentially Underlying ImRs Treatments

In the light of research into different variants of ImRs, the question arises as to which mechanisms of change may underlie ImRs in general and different ImRs approaches in particular. Arntz (2012) suggested that ImRs may work through changing the meaning of the original distressing memory (i.e., memory revaluation during reconsolidation) rather than through the formation of a new, alternative memory (i.e., inhibitory learning). One way to revaluate the original memory may be to incorporate more positive feelings and images of the self, e.g. by developing a new script within which the patient/participant experiences feelings of mastery and/or self-efficacy. **Study III** revealed that two different ImRs protocols both increased feelings of mastery but not self-efficacy. Thus, incorporating the belief in the own skills to master an aversive situation may be a way to change the meaning of the originally distressing memory. This is in line with previous research indicating that perceived mastery may play a crucial role in ImRs interventions (Germain et al., 2004; Kunze et al., 2016; Long & Quevillon, 2009; Strohm et al., 2019). Findings from the present thesis indicate that ImRs increases patients'/participants' perceived skill to master a given situation (i.e., mastery) rather than facilitate confidence building in behavior control for future situations (i.e., self-efficacy). As self-efficacy is more related to the concept of one's self, it may less easily be modified by a short single ImRs session than mastery. Even though no conclusions about repeated ImRs sessions can be drawn from the present thesis, it is conceivable that repeated experiences of successfully mastering situations may be crucial to increase feelings of self-efficacy (Bandura, Adams, & Beyer, 1977; Bandura, 1978). Thus, future research should examine the role of increasing mastery and self-efficacy by conducting studies with repeated ImRs sessions for personally relevant aversive memories. Increasing feelings of mastery may be one way to change the meaning of the original distressing memory during ImRs. However, other possible ways have been discussed (see e.g., Arntz, 2012): ImRs may work through integrating more positive emotions into the memory of the distressing event (Arntz, 2012) and reducing negative emotions (such as shame, guilt, and anger; Arntz et al., 2007; Grunert et al., 2007; Oktedalen, Hoffart, & Langkaas, 2015). Moreover, meeting unmet needs during ImRs may also facilitate changes to the meaning of the original memory (Arntz, 2012). Finally, research in patients with

social anxiety disorders suggests that ImRs may change negative beliefs about the self and others, thereby changing the beliefs originally integrated in the aversive memory (Nillson, Lundh, & Viborg, 2012; Reimer & Moscovitch, 2015). Given that negative cognitions about the self and the world also constitute key features of PTSD (Ehlers & Clark, 2000), it is conceivable that changing these dysfunctional beliefs during treatment might also be a crucial mechanism of ImRs for PTSD. Future research is recommended to specifically investigate ImRs approaches that differ content-wise with respect to the aforementioned different possible ways through which ImRs may change the meaning of the original memory.

Based on the assumption that changing the meaning of the original distressing memory may be the crucial mechanism underlying ImRs treatments, the question as to how exactly this happens with respect to memory processes has been raised (see General Introduction). Even though **Studies I** and **II** of the present thesis aimed to investigate the underlying memory mechanisms, due to procedural limitations no final conclusions could be drawn as to whether ImRs indeed leads to the revaluation of the original memory representation by updating the memory during reconsolidation (Arntz, 2012) or whether it leads to the formation of an alternative, more positive memory (Brewin, 2006). **Studies I** and **II** used the multiple-day TFP in order to enable the investigation of memory reconsolidation processes. Given that a memory must be destabilized upon retrieval in order to allow memory updating processes to occur, **Study I** included a memory reactivation task that was assumed to induce a prediction error, thereby violating expectancies and thus destabilizing the memory (Exton-McGuiness et al., 2015). A prediction error is defined as a "discrepancy between actual and expected events" (Sevenster, Beckers, & Kindt, 2013, p. 831). However, so far only few studies systematically investigated procedures to induce a prediction error (for an overview, see Beckers & Kindt, 2017) and as Kindt and Van Emmerik (2016) state, "no objective criterion is yet available to determine the optimal degree of prediction error in clinical practice" (p. 292). Although it is assumed that the procedure used in **Study I** was sufficient to induce a prediction error, this assumption could not be validated. The successful induction of a prediction error could be investigated in future studies by including a control condition without memory reactivation (i.e., without the induction of a prediction error) and/or by assessing expectancy rating prior to the memory reactivation task in order to test for violation of expectancies. As already discussed above, in **Study II** we faced the problem that no differences between conditions could be observed with respect to psychophysiological outcome measures, making it impossible to draw conclusions about underlying memory mechanisms. Future research should further improve the experimental paradigm used in **Study II**, e.g. by using different conditioning stimuli (see above

for a detailed discussion). Finally, given that prolonged exposure to an aversive memory may prevent reconsolidation processes (Lee, Milton, & Everitt, 2006; Sevenster, Beckers, & Kindt, 2014), it remains unclear whether the memory reactivation procedures used in **Study I** and **II** were sufficient to destabilize the memory but still short enough to prevent the formation of an alternative memory trace (Suzuki, Josselyn, Frankland, Masushige, Silva, & Kida, 2004). Future research is recommended to examine what might be the optimal level of reactivation prior to rescripting. Before further investigating memory reconsolidation processes during ImRs, more research is clearly needed into the preconditions that are necessary to allow memory reconsolidation to occur in experimental study designs.

Conclusion

This thesis presented three laboratory-based studies investigating the effects and potential working mechanisms of ImRs treatments for distressing memories, thereby adding to our general understanding of ImRs. The studies used advanced experimental paradigms for the induction of analogue posttraumatic reactions in healthy samples. The examination of therapeutic effects of ImRs on consolidated memories extends previous research primarily focusing on preventive effects on memory encoding and consolidation to reconsolidation processes. Moreover, this thesis contributes to the literature by systematically investigating different ImRs approaches. Even though findings from the present thesis indicate that by changing meaning-relevant content, for example by increasing feelings of mastery, ImRs might be an emotionally less stressful and aversive treatment alternative to state-of-the-art exposure-based therapies, previous positive findings on treatment outcome could not be replicated. The experimental paradigms prove to be valuable analogues to investigate processes occurring during ImRs treatment. However, the suitability of the paradigms to model the effects of ImRs on treatment outcome was impeded by several procedural limitations. Although no final conclusions about the working mechanisms underlying ImRs treatment can be drawn from the present thesis, findings point towards processes that may eventually cause change in ImRs as well as to potentials and limitations of experimental paradigms as a means to study treatment effects and working mechanisms. Moreover, by adding to the research on different ImRs approaches, the present thesis contributes to a better understanding of which ImRs may work best for whom and under which conditions. Advancing our knowledge on ImRs may enable us to improve the treatment technique and develop uniform guidelines for the use of ImRs in clinical practice.

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Zusammenfassung

Imagery Rescripting als Behandlungsmethode für belastende Erinnerungen: Experimentelle Studien zu Effekten und Wirkmechanismen

Das intrusive Wiedererleben von traumatischen Ereignissen in Form von unwillkürlichen mentalen Bildern ist ein Phänomen, das bei Patienten mit einer posttraumatischen Belastungsstörung (PTBS) häufig beobachtet werden kann (Hackman & Holmes, 2004) und ein zentrales Merkmal des Störungsbildes darstellt (American Psychiatric Association, 2013). Bei der Reaktivierung belastender mentaler Bilder können starke, negative emotionale Reaktionen ausgelöst werden (z.B. Dadds, Bovbjerg, Redd & Cutmore, 1997). Andererseits kann die Tatsache, dass mentale Bilder eine starke Wirkung auf Emotionen haben, auch in der Therapie genutzt werden, um beispielsweise durch eine Modifizierung dysfunktionaler mentaler Bilder oder eine Erzeugung positiver Bilder das emotionale Erleben positiv zu beeinflussen (Holmes & Mathews, 2010). Aus diesem Grund finden in der klinischen Praxis und Forschung zunehmend imaginationsbasierte Interventionen Anwendung, die mit mentalen Bildern arbeiten, um intrusives Wiedererleben und mit belastenden Bildern verbundene negative Emotionen zu reduzieren (Edwards, 2007; Hackmann, Bennett-Levy, & Holmes, 2011; Holmes & Mathews, 2010).

Eine solche imaginationsbasierte Behandlungsmethode ist Imagery Rescripting (ImRs). Es handelt sich dabei um einen transdiagnostischen Behandlungsansatz, der direkt darauf abzielt, dysfunktionale mentale Bilder zu verändern, indem die Bedeutung der belastenden Erinnerungen oder Bilder in der Vorstellung verändert wird (z.B. Arntz, 2012; Holmes, Arntz, & Smucker, 2007). Beim ImRs werden zunächst die belastenden Erinnerungen und mentalen Bilder sowie die damit verbundenen emotionalen Reaktionen reaktiviert. Anschließend werden diese Erinnerungen und Bilder in der Vorstellung enstsprechend den Bedürfnissen der Patient*in verändert hin zu positiveren Bildern (Arntz, 2012; Holmes et al., 2007). In bisherigen Studien hat sich ImRs als wirksame Behandlungsmethode nicht nur für PTBS (z.B. Arntz, Tiesema, & Kindt, 2007; Hackmann, 2011; Long & Quevillon, 2009; Grunert, Weis, Smucker, & Christianson, 2007; Raabe, Ehring, Marquenie, Olff, & Kindt, 2015), sondern auch für andere psychische Störungsbilder wie beispielsweise Depression (z.B. Brewin et al., 2009; Wheatley & Hackmann, 2011), Persönlichkeitsstörungen (z.B. Arntz, 2011; Weertman & Arntz, 2007) oder soziale Angststörung erwiesen (z.B. Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Strachan, Hyett, & McEvoy, 2020; Wild & Clark, 2011). ImRs scheint dabei möglicherweise dem bisherigen Goldstandard in der Behandlung von PTBS, d.h. expositionsbasierten Therapieansätzen, in einigen Aspekten überlegen zu sein: Im Gegensatz zu Expositionstherapien scheint ImRs nicht nur Angst-Emotionen zu reduzieren sondern auch eine positive Wirkung auf Nicht-Angst-Emotionen wie Wut oder Schuld zu haben (Arntz et al.,

2007; Grunert et al., 2007). Zudem legen erste Befunde nahe, dass ImRs als weniger belastend erlebt wird und zu niedrigeren Drop-Out-Raten führt als expositionsbasierte Behandlungsansätze (Arntz et al., 2007).

Obwohl sich ImRs als wirksame Behandlungsmethode erwiesen hat, gibt es aktuell eine große Variation hinsichtlich der unterschiedlichen Interventionen, welche als ImRs bezeichnet werden (Arntz, 2012; Edwards, 2007; Holmes et al., 2007) und es existieren keine einheitlichen Vorgaben, wie ImRs bestmöglich angewandt werden sollte. Bisher gibt es kaum Studien, die systematisch unterschiedliche Varianten des ImRs untersuchen. Darüber hinaus ist bisher noch wenig über mögliche Wirkmechanismen bekannt, welche dem ImRs zugrundeliegen könnten. Um jedoch die Behandlunsgmethode zu verbessern und einheitlichere Leitlinien für die Anwendung in der klinischen Praxis zu entwickeln, ist es notwendig, zunächst genauer zu verstehen, wie ImRs (bestmöglich) wirkt.

In der Literatur wurden verschiedene Gedächtnisprozesse diskutiert, die dem ImRs möglicherweise zugrunde liegen könnten. Einerseits wird von einigen Autoren angenommen, dass Inhibitionslernen den zentralen Mechanismus hinter ImRs darstellt. Hierbei handelt es sich um den gleichen Mechanismus, der auch expositionsbasierten Therapien zugrunde liegt (Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014; Foa & Kozak, 1986). Basierend auf dieser Annahme besagt die Retrieval-Competition-Hypothese, dass ImRs zur Bildung einer neuen Gedächtnisspur führt, welche bei späterer Konfrontation mit Erinnerungsreizen mit der ursprünglichen Gedächtnisspur um die Reaktivierung konkurriert (Brewin, 2006). Andere Autoren nehmen hingegen an, dass ImRs nicht zur Bildung einer neuen Gedächtnisspur führt, sondern stattdesssen direkt die Bedeutung der urprünglichen Gedächtnisrepräsentation verändert im Sinne eines Revaluationsprozesses (Arntz, 2012). Diese Annahme basiert auf Befunden moderner Lerntheorien die besagen, dass bereits konsolidierte Erinnerungen beim späteren Abruf in einen instabilen Zustand geraten und durch die Bereitstellung neuer Informationen, die inkongruent sind mit der urprünglichen Erinnerung, modifiziert werden können (Beckers & Kindt, 2017; Davey, 1997; Exton-McGuinness, Lee, & Reichelt, 2015; Mineka & Zinbarg, 2006). Im Rahmen von Rekonsolidierungsprozessen wird diese modifizierte Erinnung anschließend abgespeichert (Beckers & Kindt, 2017; Schwabe, Nader, & Pruessner, 2014). Während des ImRs könnte die ursprünglich negative Erinnerung durch die Erzeugung neuer, positiver mentaler Bilder verändert werden, die das Selbst als stark oder beschützt und unterstützt durch andere beinhalten. Dies könnte wiederum zu Gefühlen von Sicherheit, Kontrollerleben, Selbstwirksamkeit und Selbstmitgefühl führen. In Rahmen dieser

Annahmen wird beispielsweise die Förderung von Kontroll- und Selbstwirksamkeitserleben während des ImRs als zentraler Mechanismus diskutiert, der zu einer Veränderung der dysfunktionalen Bedeutung der Erinnerung führen könnte (Arntz, 2012; Kunze, Lancee, Morina, Kindt, & Arntz, 2016; Strohm, Siegesleitner, Kunz, Ehring, & Wittekind, 2019). Es wird angenommen, dass ImRs das Kontroll- und Selbstwirksamkeiterleben der Patient*innen erhöht, indem diese Kontrolle über die belastenden intrusiven mentalen Bilder gewinnen und neue, positive Bilder des Selbst als stark und fähig erzeugen. Die Frage, wie genau Kontroll- und Selbstwirksamkeiterleben während des ImRs gefördert werden können, bleibt bisher jedoch unbeantwortet. Üblicherweise werden Patient*innen während des ImRs ermutigt, sich selbst dabei vorzustellen, wie sie die Situation verändern. Sollten die Patient*innen sich jedoch nicht stark genug fühlen, so können auch Helfer imaginiert werden, die eine Veränderung der vorgestellten Situation bewirken (Arntz, 2012; Arntz & Weertman, 1999; Smucker, Dancu, Foa, & Niederee, 1995). Unklar bleibt, ob beide Formen des ImRs gleichermaßen effektiv sind, um das Kontroll- und/oder Selbstwirksamkeitserleben zu erhöhen.

Ziel der vorliegenden Doktorarbeit war es, die Effekte und möglichen Wirkmechanismen von ImRs genauer zu untersuchen. Hierfür wurden drei experimentelle Analogstudien durchgeführt, im Rahmen derer ImRs bezüglich experimentell erzeugter emotionaler Erinnerungen untersucht wurde. Analogstudien ermöglichen die Untersuchung der Entstehung und Aufrechterhaltung experimentell erzeugter Symptome, ebenso wie die Untersuchung von Behandlungseffekten und kausalen Zusammenhängen zwischen Symptomen, Interventionen und möglichen Wirkmechanismen in gesunden Stichproben unter kontrollierten und standardisierten Bedingungen (Forsyth & Zvolensky, 2002; Scheveneels, Boddez, Vervliet, & Hermans, 2016; Van den Hout, Engelhard, & McNally, 2017; Vervliet & Raes, 2013). Ein bewährtes Paradigma im Rahmen von Analogstudien ist das Traumafilmparadigma, welches auch in der vorliegenden Arbeit Anwendung fand. Im Rahmen des Traumafilmparadigmas werden gesunden Proband*innen belastende Filmausschnitte von traumatischen Ereignissen gezeigt (z.B. Unfälle, interpersonelle Gewalt), welche negative emotionale Reaktionen und vorübergehende intrusive mentale Bilder auslösen (Arnaudova & Hagenaars, 2017; Weidmann et al., 2009).

Während bisherige Analogstudien zu ImRs sich hauptsächlich mit den präventiven Effekten von ImRs auf die Gedächtniskonsolidierung befassten, war das Ziel von **Studie I** und **II** der vorliegenden Arbeit, die therapeutischen Effekte von ImRs für bereits konsolidierte Gedächtnisinhalte zu untersuchen. Hierfür fand ein mehrtägiges Traumafilmparadigma

Anwendung. **Studie I** untersuchte die therapeutischen Effekte von ImRs auf die Häufigkeit von Intusionen sowie die emotionalen Reaktionen der Proband*innen. ImRs wurde dabei mit einer expositionsbasierten Kontrollgruppe (IRE) sowie mit einer Kontrollgruppe ohne Intervention (NIC) verglichen. Die Proband*innen (N = 88) wurden zufällig einer der Gruppen zugeteilt und erhielten die entsprechende Intervention 24 Std. nach der experimentellen Induzierung der belastenden Erinnerung. Proband*innen in ImRs berichteten weniger Belastung und negative Emotionalität als Proband*innen in IRE. Die Befunde unterstützen die Annahme, dass ImRs eine vielversprechende Alternative zu traditionellen expositionsbasierten Therapien darstellen könnte. ImRs beschleunigte zudem die Reduktion intrusiver Erinnerungen. Es ist jedoch anzumerken, dass experimentell induzierte Erinnerungen innerhalb eines Tages auch ohne Intervention schnell abzunehmen scheinen, was die Interpretierbarkeit des Ergebnisses reduziert. Obwohl davon ausgegangen wird, dass das mehrtägige Traumafilmparadigma geeignet war, um Gedächtnisprozesse zu untersuchen, konnte in **Studie I** die Hypothese, dass ImRs über eine Veränderung der dysfunktionalen Bedeutung der Erinnerung wirkt, nicht direkt getestet werden. Um diese Gedächtnisprozesse genauer zu untersuchen, wurde in **Studie II** das mehrtägige Traumafilmparadigma um eine Angstkonditionierung erweitert. Dies ermöglichte auch die Untesuchung psychophysiologischer Maße. Proband*innen (N = 115) erhielten auch in **Studie II** ImRs, IRE oder keine Intervention (NIC) einen Tag nach der Induzierung der belastenden Erinnerung. Zur näheren Untersuchung, ob ImRs zur Erzeugung einer neuen, alternativen Gedächtnisspur führt (Retrieval-Competition-Hypothese), die bei Reaktivierung mit der ursprünglichen Erinnerung konkurriert oder ob ImRs zu einer Veränderung der dysfunktionalen Bedeutung der urprünglichen Erinnerung führt (Revaluationsprozess), wurde eine Rückkehr der induzierten Angstreaktion 24 Std. nach der Durchführung der Intervention untersucht. Es konnte jedoch in keiner der Bedingungen auf den psychophysiologischen Maßen eine Rückkehr der Angstreaktion beobachtet werden. Folglich konnte auch aus **Studie II** keine abschließende Schlussfolgerung über die dem ImRs zugrundeliegenden Gedächtnisprozesse gezogen werden. Möglicherweise waren prozedurale Limitationen der Paradigmen für diese unerwarteten Ergebnisse verantwortlich.

Studie III untersuchte zwei verschiedene Varianten von ImRs, eine aktive und eine passive Variante. Zudem wurden in **Studie III** Kontrollerleben und Selbstwirksamkeit als mögliche Wirkmechanismen von ImRs genauer beleuchtet. Die ImRs-Varianten unterschieden sich hinsichtlich des Inhalts des neu entwickelten Skripts: Während Proband*innen in der aktiven ImRs-Bedingung dazu aufgefordert wurden sich vorzustellen, dass sie selbst aktiv eine

Veränderung der belastenden Situation bewirken, wurden Proband*innen in der passiven ImRs-Bedingung instruiert, sich Helfer vorzustellen, die in der imaginierten Situation handeln. Die Proband*innen (N = 100) wurden zufällig einer der beiden ImRs-Bedingungen, IRE oder NIC zugeteilt. Auch wenn **Studie III** vorausgehende Befunde zu den präventiven Effekten von ImRs auf die Entwicklung von Intrusionen nicht replizieren konnte, zeigte sich ein nichtsignifikanter Trend dahingehend, dass die aktive ImRs-Bedingung die Abnahme der experimentell induzierten Intrusionen zu beschleunigen schien. Ähnlich wie in **Studie I** wurden beide ImRs-Bedingungen als weniger belastend erlebt als IRE. Somit unterstützt auch **Studie III** die Annahme, dass ImRs eine tolerierbarere Alternative zu traditionellen Expositionstherapien darstellen könnte. Beide ImRs-Bedingungen erhöhten zudem das Kontrollerleben der Proband*innen, hatten jedoch keinen positiven Effekt auf das Selbstwirksamkeitserleben. Dies kann möglicherweise damit erklärt werden, dass Selbstwirksamkeit stärker mit dem Selbstkonzept einer Person assoziiert ist und damit weniger leicht durch eine kurze Intervention verändert werden kann.

Ziel der vorliegenden Doktorarbeit war die Untersuchung von Effekten und Wirkmechanismen von ImRs im Rahmen von Analogstudien. Durch die Nutzung komplexer mehrtägiger Paradigmen zur Induzierung belastender Erinnerungen und analoger Stressreaktionen in gesunden Stichproben, konnten die Studien vorläufige Befunde zu den therapeutischen Effekten von ImRs auf bereits konsolidierte Erinnerungen liefern. Zudem trägt die vorliegende Arbeit durch die gezielte Untersuchung verschiedener ImRs-Varianten zu einem besseren Verständnis bei, welche Effekte unterschiedliche ImRs-Varianten haben und welche Prozesse möglicherweise zu einer positiven Veränderung durch ImRs führen könnten. Obwohl die analogen Forschungsparadigmen vielversprechend erschienen, um Prozesse während des ImRs zu untersuchen, konnten Interventionseffekte bezüglich Outcome-Variablen aufgrund von prozeduralen Limitationen nur begrenzt abgebildet werden. Die vorliegende Arbeit diskutiert Potentiale und Limitationen von Analogstudien zur experimentellen Untersuchung von ImRs und zeigt Implikationen und mögliche Schwerpunkte für zukünftige Forschung auf.

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