Imagery Rescripting of Aversive Autobiographical Memories: Effects and Working Mechanisms

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Effects and Working Mechanisms

Abstract

Imagery rescripting (ImRs) is an imagery-based therapeutic intervention to target aversive autobiographical memories in emotional disorders. By activating an aversive memory in imagination and then changing the imagined situation according to the individual's emotional needs, ImRs aims to update the idiosyncratic meaning of the original event. It is assumed that as a consequence recurrent intrusive images, dysfunctional beliefs, and negative emotions are reduced. Although there is growing evidence for the efficacy of ImRs in different disorders, research into its working mechanisms is only in its infancy. Laboratory-based studies in healthy individuals have been proven a suitable means to investigate mechanisms underlying psychological treatments under highly controlled conditions. In the context of ImRs research, laboratory-based studies have mainly used aversive films to induce distressing memories and associated stress symptoms which were then targeted using ImRs. However, the personal relevance of film-induced memories is limited and the ecological validity of the ImRs intervention is reduced given that the rescripting does not address memories of experiences, in which participants had been actively involved in. Aiming to overcome these limitations the current thesis presents different laboratory-based research approaches to investigate working mechanisms of ImRs for autobiographical memories of distressing real-life events.

Study I and *II* involved a preliminary examination of potential working mechanisms by testing whether ImRs enhances perceived mastery of aversive experiences ("memory revaluation") and leads to reduced emotional and physiological responding to memory retrieval. In *Study I*, healthy participants (N = 65) who had experienced a distressing life-event were randomly assigned to ImRs or a no-intervention control group (NIC). The memory of the life-event was reactivated before the intervention and at 1-week follow-up to assess memory-related processes. *Study II* aimed to optimize this analogue procedure by integrating physiological assessments in addition to self-report measures and an additional active control condition. Healthy individuals (N = 79) reporting memories of distressing real-life events were randomly allocated to ImRs, positive imagery (PI) or NIC. Subjective and physiological reactivity (heart rate, skin conductance level, and facial electromyography activity) in response to memory retrieval were assessed before the intervention and at 1-week follow-up. In *Study I* ImRs increased perceived mastery of aversive life-events when compared to NIC, however, this treatment effect could unexpectedly not be replicated in *Study II.* In both studies, distress and negative emotions in response to memory retrieval were reduced with ImRs when compared to NIC and PI. Physiological reactivity to the memories was attenuated at follow-up with no

differences between groups (*Study II*). Taken together, findings from *Studies I* and *II* only partially supported the notion that ImRs might work by changing dysfunctional meanings of mastery ("memory revaluation") and reducing problematic emotional and physiological responses to the memory.

Study III aimed to investigate the effects of ImRs compared to cognitive restructuring (CR) for social anxiety and to extend previous research by examining potential working mechanisms. During ImRs, corrective information is provided in the form of mental images, which have been found to have a powerful impact on emotions. It has been suggested that positive meanings offered in the form of images during ImRs might be more emotionally anchored than meanings generated as verbal representations (e.g., during CR). Therefore, *Study III* aimed to test whether ImRs works through emotionally anchored reappraisal of memory-related dysfunctional beliefs. Highly socially anxious individuals (N = 77) were randomly allocated to ImRs, CR, or NIC. Outcome measures were administered at baseline and 1-week follow-up. Only CR led to substantial reductions in social anxiety symptoms at follow-up. ImRs led to stronger increases in positive emotions than CR and NIC. Both active treatments yielded immediate reductions in emotionally anchored idiosyncratic self-beliefs, but CR was superior to ImRs at follow-up. Findings did not support the hypothesis that emotionally anchored reappraisal of dysfunctional beliefs is a working mechanism specific for ImRs. However, the interpretation of results on potential working mechanisms was limited as the clinical efficacy of ImRs for social anxiety symptoms could not be modelled in the subclinical sample.

Using a series of laboratory-based analogue studies, the present thesis aimed to shed light on the working mechanisms of ImRs. Findings from the current studies add to our knowledge on processes that might underlie the therapeutic efficacy of ImRs, although only preliminary conclusions can be drawn about potential working mechanisms. An investigation of processes involved in ImRs within the presented research paradigms appears to be promising, but modifications are necessary as the clinical efficacy of ImRs could not be modelled reliably. Possible directions for future research into working mechanisms of ImRs are outlined. Moreover, potentials and limitations of laboratory-based investigations in the context of ImRs are discussed.

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1. General Introduction

Aversive autobiographical memories in emotional disorders

"Autobiographical memory is memory for the events of one's life. […] [I]t constitutes a major crossroads in human cognition where considerations relating to the self, emotion, goals, and personal meanings all intersect" (Conway & Rubin, 1993, p. 103). Autobiographical memories of personally experienced events are central to human functioning (Williams et al., 2007). They are crucial for an individual's orientation in the world, for successful goal pursuit and problem solving, and for the formation of a sense of self (Williams et al., 2007; Conway, 2005). However, when individuals experience highly distressing or traumatic events, autobiographical memories can become a burden, which may contribute to the development of an emotional disorder (e.g., Brewin, 2011; Hackmann, Clark, & McManus, 2000; Martins-Monteverde, 2019; Norton & Abbott, 2017).

For example, in posttraumatic stress disorder (PTSD) persistent involuntary memories of traumatic events, which are experienced in form of distressing intrusive mental images, constitute a hallmark symptom of the disorder (American Psychiatric Association [APA], 2013). In recent years, there has been growing evidence that intrusive memories of past negative events do not only play a role in PTSD, but are a common feature of many emotional disorders (Brewin, Gregory, Lipton, & Burgess, 2010; Hirsch & Holmes, 2007; Holmes & Mathews, 2010), including social anxiety disorder (SAD; e.g. Hackmann et al., 2000; Norton & Abbott, 2017), depression (e.g., Holmes, Blackwell, Heyes, Renner, & Raes, 2016), and eating disorders (e.g., Somerville, Cooper, & Hackmann, 2007). Intrusive memories are typically experienced as spontaneously occurring, involuntary vivid mental images, which may also comprise sensory-perceptual elements of the event, such as somatic, auditory, olfactory, or gustatory elements (Brewin et al., 2010; Holmes & Mathews, 2010; Marks, Franklin, & Zoellner, 2018). The experience of highly distressing or traumatic events can not only result in the development of intrusive memories, but may also be critically involved in the development of dysfunctional beliefs (or schemas) about the self, others and the world, which are at the heart of many emotional disorders (e.g., Beck, Emery, & Greenberg, 1985; Clark & Wells, 1995; Ehlers & Clark, 2000; Young, Klosko, & Weishaar, 2003). Moreover, memories of highly distressing or traumatic events may be linked to problematic emotional and physiological responding to the event memory itself, but also to situations that remind individuals of the original experience. In order to avoid distress associated with the activation of the aversive memories, individuals often use maladaptive behavioral strategies such as avoidance, safety behavior, and withdrawal (e.g., Ehlers & Clark, 2000; Foa, Steketee, &

Rothbaum, 1989; Hackmann et al., 2000). In order to reduce symptoms linked to aversive autobiographical memories, imagery-based therapeutic interventions have been increasingly integrated in cognitive behavioral therapy (CBT) across emotional disorders (Edwards, 2007; Holmes, Arntz, & Smucker, 2007). One of these imagery-based techniques is imagery rescripting (ImRs), a promising treatment strategy that in recent years has gained growing interest in clinical research and practice.

Imagery rescripting as a transdiagnostic treatment approach for aversive memories

ImRs is an imagery-based therapeutic technique to target aversive autobiographical memories in emotional disorders (e.g., Arntz, 2012; Holmes et al., 2007). By changing negative memories into more positive mental images, ImRs aims to update the idiosyncratic meaning of the original event thereby reducing recurrent intrusive images, dysfunctional beliefs, and negative emotions (Arntz, 2012; Morina, Lancee, & Arntz, 2017). ImRs has originally been developed to reduce symptoms associated with traumatic childhood memories (Arntz & Weertman, 1999; Smucker, Dancu, Foa, & Niederee, 1995). However, in recent years, various forms of ImRs have been incorporated in CBT for a number of emotional disorders such as PTSD (e.g., Arntz, Tiesma, & Kindt, 2007; Grunert, Weis, Smucker, & Christianson, 2007; Øktedalen, Hoffart, & Langkaas, 2015; Raabe, Ehring, Marquenie, Olff, & Kindt, 2015), SAD (e.g., Hyett et al., 2018; Lee & Kwon, 2013; McEvoy & Saulsman, 2014; Nilsson, Lundh, & Viborg, 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild & Clark, 2011), depression (e.g., Brewin et al., 2009; Moritz et al., 2018), personality disorders (e.g., Arntz, 2011; Weertman & Arntz, 2007), and nightmare disorder (e.g., Kunze, Arntz, Morina, Kindt, & Lancee, 2017).

Although different treatment protocols have been proposed (for an overview, see e.g., Holmes et al., 2007), all ImRs variants share the common goal to emotionally activate memory-related mental images and to change the negative mental images into more benign ones according to the individual's personal needs (Arntz, 2012; Holmes at al., 2007). The present thesis primarily focused on the protocol developed by Arntz and Weertman (1999) for the treatment of traumatic childhood memories. According to this protocol, ImRs is delivered in three phases (see Table 1.1): During Phase 1, the patient re-experiences the original aversive scene from the child's perspective. During Phase 2, patients imagine themselves to enter the mental image as an adult. The adult self is encouraged to observe what is happening

to the child and to intervene, for example by disempowering the perpetrator, confronting others, and saving and/or supporting the child. During Phase 3, patients are instructed to again re-experience the scene from the child's perspective, but this time including the interventions by the adult. Furthermore, patients are encouraged to verbalize from the child's perspective any further actions or unmet needs that he/she requires from the adult self (e.g., emotional support, distraction).

Table 1.1. Basic model of imagery rescripting by Arntz & Weertman (1999)

Phase	**Perspective**	**Aim**	**Description**
1	Child	Emotional activation	The patient re-experiences the original aversive scene.
2	Adult	Rescripting	The patient views the scene from an adult perspective and intervenes.
3	Child	Rescripting	The interventions by the adult self are experienced by the patient from a child perspective. Patient as a child receives further interventions and/or emotional support from the adult self.

Findings from a recent meta-analysis have shown that ImRs interventions are effective in reducing psychopathology related to distressing memories in different disorders, including PTSD, SAD, depression, bulimia nervosa, body dysmorphic disorder, and obsessive compulsive disorder (Morina et al., 2017), thereby underlining its potential as a transdiagnostic treatment approach. With an average of 4.5 sessions, ImRs yielded large pre- to posttreatment effect sizes (Hedge's g = 1.22). However, limitations of the meta-analysis are that only PTSD (8 studies) and SAD (6 studies) were relatively well represented and that ImRs was delivered in combination with other interventions in some of the studies (Morina et al., 2017). Randomized controlled trials with adequate statistical power are still needed for a

number of disorders. Additionally, studies comparing ImRs as a stand-alone intervention with well-established CBT interventions are required. Preliminary evidence indicates that ImRs might be as effective as imaginal exposure treatment for PTSD (Øktedalen et al., 2015) and cognitive restructuring (CR) for SAD patients (Norton & Abbott, 2016). Moreover, ImRs might be superior to imaginal exposure in targeting non-fear emotions such as guilt, shame, and anger (Arntz et al., 2007; Grunert et al. 2007; but see also Øktedalen et al., 2015). Finally, when compared to prolonged exposure, ImRs has been perceived as a more tolerable alternative (for patients and therapists) thereby possibly leading to lower drop-out rates (Arntz et al., 2007).

In sum, ImRs can be considered a promising transdiagnostic treatment approach. However, until now little is known about its working mechanisms. A number of different ImRs protocols have been developed for different emotional disorders (e.g., Arntz & Weertman, 1999; Smucker et al., 1995; Wild & Clark, 2011) and for the purpose of experimental research in analogue settings (e.g., Hagenaars & Arntz, 2012; Seebauer, Froß, Dubaschny, Schönberger, & Jacob, 2014; Tolgou et al., 2018; Watson, Rapee, & Todorov, 2016). In order to answer the question how ImRs is most effectively delivered, it is crucial to understand the mechanisms underlying its treatment effects (Kazdin, 2009).

Working mechanisms of imagery rescripting

Research into the working mechanisms of ImRs is only in its infancy – or as noted by Arntz: "ImRs, although a powerful technique, seems to be a technique in need of a theory" (Arntz 2012, p. 200). It has been suggested that ImRs works by activating and revaluating the memory of the original event, which is then stored with a less negative meaning (Arntz, 2012). Meanings of current threat, for example, might be modified by changing mental images of the original aversive situation into more positive images of the individual being safe and protected. Perceiving control over what is happening in the aversive memory might (re-)establish a sense of mastery or self-efficacy and reduce beliefs about uncontrollability and the self being incompetent. Dysfunctional appraisals about the self being helpless, worthless or a bad person might be revaluated by rescripting the memory in a way that the traumatized self gets protection, support, and comfort by the adult self or another person (see e.g., Arntz & Weertman, 1999; Hackmann, 2011). By changing the dysfunctional meaning of one specific memory of an autobiographical event ("memory revaluation"), ImRs is suggested

to decrease memory-related emotional distress as well as (more generalized) memory-derived dysfunctional beliefs (Arntz, 2012). Importantly, however, ImRs is not assumed to yield symptomatic change by modifying factual details of the distressing event-memory (see Hagenaars & Arntz, 2012; Siegesleitner, Strohm, Wittekind, Ehring & Kunze, 2019a). Preliminary evidence from laboratory-based studies using film-induced memories supports the notion that ImRs leads to a revaluation of the negative valence of memory representations (Dibbets & Arntz 2016; Dibbets, Lemmens, & Voncken, 2018; Hagenaars & Arntz 2012). Further evidence for this working mechanism stems from studies in SAD demonstrating that ImRs reduces negative meanings, emotions, and distress associated with memory retrieval of aversive social experiences (Nilsson et al., 2012; Reimer & Moscovitch, 2015). Findings from a study in patients with idiopathic nightmare disorder indicate that ImRs might specifically work by enhancing perceived mastery of nightmare contents (Kunze, Lancee, Morina, Kindt, & Arntz, 2019). Although this preliminary evidence indicates that ImRs might modify dysfunctional meanings of aversive memory representations as well as memory-related emotional responses, it needs to be tested whether results for film-induced memories and nightmare contents generalize to memory contents of distressing real-life experiences. Moreover, in addition to subjective self-report measures, an investigation of physiological processes may significantly contribute to a better understanding of mechanisms underlying ImRs. If the intervention indeed changes the dysfunctional meaning of memory representations of highly distressing or traumatic events this should result in reduced physiological responding to memory retrieval (Arntz, 2012; see also Foa et al., 1989). However, it has not been investigated yet whether ImRs reduces the physiological reactivity to autobiographical memories of real-life events.

In the context of SAD research, an alternative (but related) mechanism has been proposed to underlie ImRs, namely *emotionally anchored reappraisal* of memory-related beliefs (Nilsson et al., 2012; Norton & Abbott, 2016; Wild et al., 2008). During ImRs, corrective information is provided in the form of mental images. Significant overlap has been found in brain areas involved in mental imagery and the perception of equivalent real-life events (Holmes & Mathews, 2010). In line with these findings, mental images of personal experiences appear to have a powerful impact on emotions (Holmes & Mathews, 2010). Given the special link between imagery and emotions, it has been suggested that alternative meanings offered in the form of images might be more emotionally anchored and more believable than meanings that are generated as verbal representations (Holmes & Mathews,

2010). In other words, ImRs might change meaning representations on an implicational level ("knowing with the heart"), while verbal-cognitive treatment strategies (e.g., CR) are assumed to change beliefs on a propositional level ("knowing with the head"; see Model of Interacting Cognitive Subsystems, Barnard & Teasdale, 1991). For clinical practice, this hypothesized treatment mechanisms appears to be highly relevant, as ImRs might be more effective compared to CR if it indeed facilitates emotionally anchored reappraisal. Preliminary evidence has shown that ImRs reduces dysfunctional emotional beliefs (i.e., meaning representations on the implicational level) in patients with bulimia nervosa (Cooper, Todd, & Turner, 2007). However, more systematic investigations are needed to answer the question whether these results generalize to ImRs in other emotional disorders (e.g., SAD) and whether ImRs is indeed superior to cognitive interventions in fostering emotionally anchored reappraisal.

Laboratory-based approaches to investigate working mechanisms of imagery rescripting

In order to investigate mechanisms involved in psychological treatments, laboratory-based research in healthy samples can be considered a valuable means. By modeling psychopathological processes and their treatment in healthy samples, analogue research paradigms allow systematic investigations of treatment mechanisms in a highly controlled and standardized setting (for reviews, see Scheveneels, Boddez, Vervliet, & Hermans, 2016; Van den Hout, Engelhard, & McNally, 2017; Vervliet & Raes, 2013). Moreover, laboratory-based studies in analogue samples are usually more cost-effective and less time-consuming when compared to clinical studies. In the context of ImRs, laboratory-based research has mainly used aversive films to induce distressing memories, which were then targeted by ImRs (e.g., Dibbets & Arntz 2016; Dibbets et al., 2018; Hagenaars & Arntz 2012; Kunze, Arntz, & Kindt, 2019; Seebauer et al., 2014). However, importantly, ecological validity of the trauma film paradigm (TFP) is limited, as film-induced memories lack personal relevance for the individual, do typically not encapsulate negative idiosyncratic meanings about the self and do usually not evoke non-fear emotions such as guilt or shame, which are highly relevant in a number of patient populations (e.g., Beck et al., 2011; Kim, Thibodeau, & Jorgensen, 2011; Lee, Scragg, & Turner, 2001). Moreover, in this previous analogue research ImRs interventions did not involve the rescripting of autobiographical memories of real-life experiences, in which participants had been actively involved in. In order to overcome these

limitations the present thesis aims to develop and evaluate alternative analogue research approaches to investigate mechanisms underlying ImRs under highly controlled conditions. Aiming to enhance the ecological validity, ImRs is examined in the context of autobiographical memories of distressing real-life experiences.

Aims of the present thesis

The aim of the present thesis is to shed light on the mechanisms underlying ImRs as a transdiagnostic treatment approach for aversive autobiographical memories and associated symptoms. In order to overcome limitations of previous laboratory research using the TFP, an analogue paradigm to study ImRs in autobiographical memories of distressing real-life events is presented and tested in *Study I*. Moreover, *Study I* involves a preliminary examination of potential working mechanisms of ImRs by testing whether ImRs reduces subjective emotional responding to the memory and enhances perceived mastery of aversive events. Based on the findings of *Study I*, *Study II* aims to optimize the analogue paradigm by integrating physiological assessments in addition to self-report measures. The aim of *Study II* is to replicate findings of *Study I* on subjective outcomes (emotional responding; perceived mastery) using an additional active control condition (positive imagery strategy) and to extend findings by examining whether ImRs attenuates the physiological reactivity to aversive autobiographical memories. Finally, *Study III* addresses limitations of *Studies I* and *II* by examining ImRs in a subclinical sample of highly socially anxious individuals who report higher levels of baseline-symptoms and idiosyncratic dysfunctional self-beliefs. Moreover, ImRs is compared to an active treatment condition (i.e., CR). *Study III* aims to replicate previous evidence on the stand-alone effects of one session of ImRs versus CR for social anxiety and to test whether ImRs works through emotionally anchored reappraisal of memory-related dysfunctional beliefs.

2. Study I:

Imagery Rescripting of Aversive Autobiographical Memories: Effects on Memory Distress, Emotions, and Feelings of Mastery

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Abstract

Imagery rescripting (ImRs) has been shown to be a promising intervention for aversive emotional memories, but research on underlying mechanisms is only in its beginnings. Previous analogue studies on ImRs were mainly based on the trauma film paradigm, but the personal relevance of film-induced memories is limited. Therefore, the present study aimed to investigate the effects of ImRs on personally relevant autobiographical memories. Sixty-five participants who had experienced a distressing life-event were randomly assigned to ImRs or no-intervention control (NIC). ImRs led to less intrusive memories than NIC during the 1-week follow-up period, but was not superior in reducing overall event-related stress symptoms. When retrieving the memory after one week, ImRs participants reported greater reductions in sadness and distress, and higher feelings of mastery. Findings underline the potential of the paradigm used in this study to test memory processes involved in ImRs. Limitations and modifications of the paradigm are discussed.

Introduction

Imagery rescripting (ImRs) has been shown to be a promising intervention for disorders associated with aversive emotional memories (Arntz, 2012; Morina, Lancee, & Arntz, 2017). ImRs is applied transdiagnostically to reduce distressing intrusive images, negative emotions, and dysfunctional beliefs by activating an aversive memory in imagination and then changing the imagined situation according to the individual's emotional needs (Arntz, 2012; Holmes, Arntz, & Smucker, 2007). For example, a patient with posttraumatic stress disorder (PTSD) might rescript negative mental images of the traumatic event into more benign ones by imagining that he or she successfully disempowers the perpetrator and then gets emotional support by others (Arntz, 2011; Arntz & Weertman, 1999). Although there is growing evidence for the efficacy of ImRs in different disorders (Arntz, 2012; Morina et al., 2017), research into the underlying mechanisms is only in its infancy. Or as stated by Arntz: "ImRs, although a powerful technique, seems to be a technique in need of a theory" (Arntz, 2012, p. 200). A deeper understanding of the mechanisms underlying ImRs will be essential to optimize its treatment effects (Kazdin, 2009).

In addition to clinical studies, laboratory-based studies in healthy individuals have been proven a suitable means to systematically investigate underlying mechanisms of psychological treatments (for reviews, see Scheveneels, Boddez, Vervliet, & Hermans, 2016; van den Hout, Engelhard, & McNally, 2017). In these analogue paradigms, both etiological models and treatment processes can be examined under highly controlled and standardized conditions and in a more cost-effective and less time-consuming way (Scheveneels et al., 2016; Vervliet & Raes, 2013). Past analogue studies investigating ImRs were mainly based on the trauma film paradigm (TFP; for reviews, see Holmes & Bourne, 2008; James et al., 2016). In these studies, aversive film material was presented to induce emotional memories and ImRs was used to modify these memories and/or associated stress symptoms (e.g., Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012; Seebauer, Froß, Dubaschny, Schönberger, & Jacob, 2014). However, some important limitations of the TFP have to be considered in the context of ImRs research:

Within the TFP there is a lack of personal relevance of the induced emotional memory. While watching stressful films, participants are in a passive third person perspective, observing aversive events on a screen instead of being actually involved in them. Participants in recent TFP studies reported that they had been constantly aware that it is "only" a film, thus

experiencing high levels of control (Dibbets & Arntz, 2016; Dibbets & Schulte-Ostermann, 2015). Personal relevance of film-induced memories is also restricted by the fact that aversive film contents do not affect the individual's life to the same extent as real-life experiences (e.g., impact on relationships, on the image of the self, on longer-term emotionality, cognitions, etc.). Consequently, film-induced memories differ importantly from emotional memories usually targeted with ImRs in clinical practice. As ImRs aims not only to change negative images of the aversive event, but also targets negative meanings and beliefs about the self (Holmes et al., 2007; Wild & Clark, 2011), it appears crucial to examine ImRs in the context of personally relevant memories.

Furthermore, analogue symptoms induced within the TFP are typically short-lived (Arnaudova & Hagenaars, 2017; James et al., 2016). In the context of ImRs research the majority of TFP studies have focused on intrusive memories as main outcome. However, the number of intrusive memories related to film contents usually declines rapidly within the first days after viewing the film, even without any intervention (e.g., James et al., 2015). This leads to floor effects that make it difficult to investigate the modulation of intrusive memories by therapeutic strategies. Additionally, as ImRs is used in several disorders to target not only intrusive memories but a wider range of psychopathological problems (Arntz, 2012), analogue paradigms are needed in which intervention effects on different types of symptoms can be modelled.

Finally, it remains questionable whether memories associated with non-fear emotions like anger, guilt, or shame can be induced using aversive films (Dibbets & Arntz, 2016). In light of recent findings that ImRs might be superior to exposure-based interventions in targeting non-fear emotions (Arntz, Tiesema, & Kindt, 2007; Grunert, Weis, Smucker, & Christianson, 2007), analogue paradigms in the context of ImRs research should allow an examination of these emotions.

In order to address the outlined limitations of the TFP, the present study tests an analogue paradigm which investigates ImRs in *autobiographical memories of distressing real-life events* (for similar approaches in the context of Eye Movement Desensitisation and Reprocessing, see e.g., van den Hout, Muris, Salemink, & Kindt, 2001). Thus, we aimed to provide a paradigm which allows exploring mechanisms underlying ImRs in the context of personally relevant memories, which are associated with a larger range of emotions and more persistent stress reactions in daily life than film-induced memories.

It has been suggested that one mechanism underlying ImRs might be that it changes the meaning of the memory representation of aversive events, thereby reducing the strong negative emotional response to the memory (Arntz, 2012). This idea is in accordance with growing evidence that memories can be changed when first reactivated and then re-evaluated during the process of *reconsolidation* (for reviews on memory reconsolidation interference, see Beckers & Kindt, 2017; Schwabe, Nader, & Pruessner, 2014). Recent lab studies provide preliminary evidence that ImRs indeed changes the meaning of memory representations of aversive (film/picture) stimuli and reduces associated negative emotional responses as well as intrusion development (Dibbets & Arntz, 2016; Dibbets, Poort, & Arntz, 2012; Hagenaars & Arntz, 2012). However, in these studies ImRs was examined during the process of memory formation, i.e. during consolidation, as ImRs was employed on the same day of film/picture presentation. Only a limited number of studies have investigated the effects of ImRs on emotional responses to already consolidated autobiographical memories when these memories are retrieved again after the intervention (e.g., Cili, Pettit, & Stopa, 2016; Slofstra, Nauta, Holmes, & Bockting, 2016). An investigation of consolidated memories is arguably more relevant from a clinical perspective, given that ImRs is usually applied as a *therapeutic* treatment method rather than a *preventive* strategy. Findings by Çili et al. (2016) showed that ImRs reduces negative affect and distress in a non-clinical sample when retrieving aversive autobiographical memories, but due to the lack of a control condition it remains unclear whether changes were produced solely by the intervention. In social anxiety disorder, ImRs has been found to decrease negative emotions and distress elicited by memories of aversive social experiences when compared with no intervention control conditions (Nilsson, Lundh, & Viborg, 2012; Reimer & Moscovitch, 2015). In a series of experiments by Slofstra et al. (2016) different ImRs variations were compared, but for Conceptual-ImRs (i.e., changing meaning-relevant memory content as done in clinical practice) no consistent effects on the unpleasantness and emotionality (anxiety, sadness, helplessness) of autobiographical memories were found. As the effects of ImRs (and the control tasks) were assessed in a within-subject design immediately after the interventions, no conclusions about longer-term outcomes can be drawn from this study. In sum, there is first evidence for the notion that ImRs changes the meaning of aversive memory representations and the associated emotional response (Çili et al., 2016; Nilsson et al., 2012; Reimer & Moscovitch, 2015), but replications in controlled study designs examining longer-term effects (e.g., when retrieving the memory several days after the intervention) are clearly needed.

It has been further proposed that ImRs works through enhancing feelings of mastery (Kunze, Lancee, Morina, Kindt, & Arntz, 2016). During ImRs, the individual is empowered to actively change mental images of aversive experiences and to express action tendencies that have been inhibited in the original situation (Arntz, 2012). This may not only help to increase perceived mastery over intrusive images (Germain, 2004; Long & Quevillon, 2009), but also modify maladaptive beliefs about mastery of aversive events. First evidence for the notion that ImRs works through increasing feelings of mastery (of the nightmare content) stems from a recent study in patients with nightmare disorder (Kunze, Lancee, Morina, Kindt, & Arntz, 2019). However, it remains an open question whether ImRs equally enhances feelings of mastery of aversive experiences when used as a treatment strategy for individuals who have experienced distressing life-events.

The aims of the present study were twofold. First, the study aimed to evaluate the usefulness of an adapted analogue paradigm for the investigation of ImRs in aversive autobiographical memories. In a two-day procedure, healthy individuals who had experienced an aversive life-event and who still felt distressed by this event in daily life were randomly allocated to ImRs or a no-intervention control condition (NIC). Levels of stress symptomatology were assessed at baseline and at 1-week follow-up; intrusion frequency in daily life was additionally measured during the week after the intervention. The memory of the life-event was reactivated before the intervention and at 1-week follow-up to assess memory-related processes. In order to evaluate the paradigm, we tested whether stress symptoms associated with the aversive life-events can be modified using ImRs. Based on the efficacy of ImRs in clinical samples, we expected ImRs to be superior to NIC in reducing event-related stress symptoms (i.e., intrusions, avoidance, hyperarousal; *Hypothesis 1*) as well as intrusion frequency in daily life (*Hypothesis 2*). The second aim of this study was a preliminary examination of mechanisms possibly underlying ImRs by investigating (1) whether ImRs changes the emotional response to consolidated autobiographical memories and (2) enhances feelings of mastery of aversive events. Specifically, we hypothesized that participants receiving ImRs would report significantly greater reductions of distress (*Hypothesis 3*) as well as fear and negative non-fear emotions (*Hypothesis 4*) in response to memory reactivation (baseline to 1-week follow-up) compared to NIC. We expected ImRs to be superior to NIC in enhancing feelings of mastery (*Hypothesis 5*). To explore the short-term impact of the ImRs intervention on affect and distress, we conducted several exploratory analyses on the immediate pre- to post-intervention effects.

Method

Participants

Individuals who had experienced a distressing life-event in the past 24 months (e.g., relationship break-up, job loss, interpersonal conflicts) and still felt distressed by this event were recruited via advertisements on campus at LMU Munich and via social media. In session 1, a short structured interview (developed for the purpose of this study) was administered in order to assess the following event-related a priori inclusion criteria: (1) experience of a distressing but non-traumatic event (according to criterion A of DSM-5, American Psychiatric Association, 2013) within the past 24 months, (2) recurrent distressing memories of the event during the last week in the form of (a) intrusive thoughts or images, (b) nightmares or (c) emotional/physical responding to reminders of the event, (3) at least moderate distress at the time the event happened (rating of at least 50 on a 0-100 scale, ranging from *not at all distressed* to *extremely distressed*), and (4) levels of distress at the time of study participation of at least 30 (on the same 0 – 100 scale). Death of a close person was excluded as distressing life-event due to ethical concerns that study participation after a recent loss may disturb the natural mourning process. The following exclusion criteria were assessed using the German version of the Mini International Neuropsychiatric Interview for DSM-IV (M.I.N.I 5.0.0; Sheehan et al., 1998; German version: Ackenheil, Stotz-Ingenlath, Dietz-Bauer, & Vossen, 1999) and a short screening interview: (1) current diagnosis of a mental disorder, (2) acute suicidal tendencies, (3) lifetime diagnosis of PTSD/ psychotic disorder/ bipolar disorder, (4) psychological treatment at the time of study participation, (5) severe physical illness, (6) pregnancy, and (7) age below 18 or above 30 years. These exclusion criteria were defined for ethical reasons (Criteria 1 – 6: concern that study participation may lead to higher emotional distress in potentially vulnerable individuals) and in order to ensure homogeneity of the study sample regarding age (Criterion 7).

A total of 103 participants were recruited, 35 of which had to be excluded (n = 16 current or lifetime diagnosis of mental disorder; n = 16 did not meet inclusion criteria regarding the life-event; n = 3 were aged > 30). In addition, three participants did not attend the follow-up session and were therefore excluded from data analyses[1].

[1]One of these participants withdrew their consent for the study and therefore no data is available. When including the remaining two participants in analyses of Session 1 (manipulation check and exploratory analyses) results remained unchanged.

The final sample comprised 65 students (81.5% female; age: M = 22.65, SD = 2.90). All gave written informed consent and were reimbursed by receiving either 25€ or partial course credit. The study was approved by the Ethics Committee of the Department of Psychology at LMU Munich.

Tasks

Memory reactivation task

The memory reactivation task was developed for the purpose of this study. The aim of this task was to reactivate the emotional memory in both experimental conditions and during both sessions so that reactions to memory retrieval (memory distress, negative emotions, mastery) could be assessed (see Hypotheses 3-5). In order to get a specific memory for the memory reactivation task (which was important in the case of longer lasting life-events or repeating aversive events), participants were first asked to specify the concrete situation (or "scene") of their distressing life-event that they most frequently re-experienced in their intrusive memories. This procedure was chosen to determine the most relevant intrusive memory. For memory reactivation, participants were then instructed to provide a detailed 3-5 min description of this specific aversive memory. The experimenter supported the description with active listening. Only in case participants stopped the narrative or did not talk about the actual event-memory, experimenters asked questions to stimulate a more detailed description or to come back to the memory. When participants were about to exceed the pre-defined time-window, they were encouraged to conclude their description, but were not immediately interrupted. Subsequently, the hotspot was determined by asking participants for the most distressing moment while talking about the aversive memory. The experimenter made a note of the specific memory that was used for the memory reactivation task in Session 1 to ensure that the same memory was reactivated in Session 2.

Filler task

Based on the assumption that ImRs may work through memory updating processes during reconsolidation (Arntz, 2012), memory reactivation was followed by a 10-min standardized music filler task as used in James et al. (2015) to allow enough time for possible memory reconsolidation processes to be initiated before the intervention started. The specific duration of the filler task is based on previous studies targeting reconsolidation update

mechanisms in humans (James et al., 2015; Schiller et al., 2010). Participants were presented excerpts of classical music which they rated for pleasantness.

Experimental conditions

Imagery rescripting (ImRs)

The ImRs procedure was developed based on the protocol by Arntz and Weertman (1999), but with major adaptions with respect to the phases of the imagery exercise (as life-events had happened recently, participants were not instructed to experience the event from the adult's and the child's perspective). The intervention protocol was semi-structured with standardized instructions and questions, which could vary in order depending on the individual rescripting process. Experimenters were extensively trained and supervised during the study by the first author.

Before ImRs started, the experimenter gave a short demonstration of an imagery exercise (description of a regular day's breakfast), but no rationale was provided. For the ImRs intervention, participants were then encouraged to close their eyes and to vividly imagine the previously defined aversive memory (see "Memory reactivation task" section). Participants were instructed to describe their experiences out loud from the first person perspective, in present tense, and including all sensory modalities. The following questions were asked to support participants (see Arntz & Weertman, 1999): *What happens? What do you see/ hear/ smell? What do you feel? What is going through your mind?* This first phase of the ImRs procedure (affective activation; duration: M = 3.87 min, SD = 1.84) was used to reactivate emotions related to the memory and included the individual hotspot. The second phase of ImRs (rescripting of the memory; duration: M = 13.81 min, SD = 4.38) started immediately after the hotspot and was initiated by instructing participants to change the "script of the scene" in any desired way to make it less distressing. Changes could be realistic or unrealistic (with the exception of undoing what has happened before and during the hotspot of the memory; see Dibbets & Arntz, 2016). Participants were asked to vividly imagine the new script and to describe it in detail to the experimenter (starting immediately after the hotspot, not at the beginning of the scene). The following questions were asked to support the rescripting (see Arntz & Weertman, 1999): *What would you like to do/say? Ok, do it/say it! What do you feel? What do you think? Is there anything else you would like to change? Is there anything (else) you need?* When participants felt fully satisfied with the new outcome

and did not wish to apply further changes to the script, they were encouraged to conclude the ImRs procedure by dwelling on the final positive image for a moment.

No intervention control condition (NIC)

The no-intervention control condition consisted of a 20-min break. Participants spent the time waiting alone in the laboratory and were provided some selected magazines. The control group was used to control for time effects (e.g., spontaneous recovery) and for unintended beneficial effects of the experimental procedure (e.g., placebo effects caused by mere study participation, assessment reactivity).

Measures

Event-related stress symptoms

Stress symptoms in response to the distressing life-event were assessed using the Impact of Event Scale-Revised (IES-R; Weiss & Marmar, 1997; German version: Maercker & Schützwohl, 1998). The IES-R is a 22-item self-report questionnaire measuring posttraumatic symptoms over the past seven days on three subscales: intrusions, avoidance, and hyperarousal. Based on the original English version of the IES-R (Weiss & Marmar, 1997), we used a 5-point response-scale ranging from 0 (*not at all*) to 4 (*extremely*). Participants were explicitly instructed to answer items with respect to their distressing life-event.

Intrusive memories

A short questionnaire was administered at baseline in order to assess intrusive memories of the life-event during the past week. Participants were asked to indicate the number and the type of their intrusions (images, thoughts, or combination of images and thoughts) as well as associated distress (on a scale ranging from 0 [*not at all distressed*] to 10 [*extremely distressed*]).

The number of intrusions during the week following the intervention were measured via a smartphone app (movisensXS), which was based on frequently used paper pencil intrusion diaries (e.g., Holmes, Brewin, & Hennessy, 2004; James et al., 2015). Intrusive memories were defined as images or thoughts of the life-event that occur spontaneously and non-deliberately (this definition was provided verbally as well as in written form in the questionnaire and in the smartphone app). Participants were instructed to carry the

smartphone with them all day and to open the app immediately when an intrusive memory occurred. The app then asked for the content of the intrusion, the situation that triggered the intrusion, and the type of intrusion (image, thought, or combination of image and thought). To enhance compliance, participants received a message every evening asking them to fill in every intrusion that they had not reported on that same day. Intrusive memories recorded via the app were rated by two independent raters (both blind to experimental condition) using the following categories: (1) intrusive memories of the distressing life-event itself (i.e., of the aversive memory targeted in the study), (2) intrusive memories, which are related to the life-event, but have not explicitly been targeted during study participation (e.g., intrusive memories of past situations with the ex-partner, but not of the break-up itself), (3) intrusive memories of positive images of the ImRs, (4) no intrusive memory (e.g., rumination). Interrater agreement was satisfactory (κ = .74). In case of disagreement, ratings were discussed by the two raters to reach a consensus. In accordance with our hypotheses only intrusive memories of category (1) and (2) were included in data analyses. We analyzed intrusions of the two categories separately in order to detect differential effects.

Distress

Subjectively experienced levels of event-related distress were assessed before and after the intervention as well as after the memory reactivation task using Subjective Units of Distress (SUD) on a 100-mm visual analogue scale ranging from 0 (*not at all distressed*) to 100 (*extremely distressed*).

Negative emotions

Six 100-mm visual analogue scales (VAS) ranging from 0 (*not at all intense*) to 100 (*extremely intense*) were administered for one fear emotion (*anxiety*) and five distinct non-fear emotions (*anger, sadness, shame, guilt,* and *disgust)* to assess emotional reactions in response to the memory reactivation task. The emotions were always presented in the same order (as listed above).

Mastery

Mastery was assessed after the memory reactivation tasks and was operationalized as perceived ability to control the aversive situation of the distressing life-event. Participants were asked verbally to rate their feelings of mastery regarding the aversive situation in their

memory ("How controllable do you experience the situation that you just described to me, on a scale ranging from 0 [*not at all controllable*] to 100 [*very controllable*]?").

Positive and negative affect

Changes in positive and negative affect in response to ImRs were measured immediately before and after the intervention (and NIC) using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988; German version: Krohne, Egloff, Kohlmann, & Tausch, 1996).

Procedure

The study comprised two sessions (conducted by the same experimenter), which were exactly one week apart. For an overview of the study procedure see Figure 2.1.

Session 1

Participants were administered the diagnostic interviews to check for inclusion and exclusion criteria, followed by baseline measures (t0: sociodemographic data, IES-R, intrusion questionnaire, PANAS, SUD, VAS negative emotions). Next, the memory reactivation task was administered, followed by memory ratings (t1: SUD, VAS negative emotions, mastery) and the filler task. Participants then filled out pre-treatment questionnaires (t2: SUD, PANAS) and were randomly allocated to ImRs (n = 31) or NIC (n = 34). Immediately after the intervention (or NIC), participants completed post-treatment measures (t3: SUD, PANAS) and were provided with verbal and written instructions on the nature of intrusive memories and the correct usage of the intrusion diary.

Session 2

Participants first filled in the follow-up questionnaire (t4: IES-R). Then, the aversive memory was reactivated using the same reactivation task as in Session 1 followed by memory ratings (t5: SUD, VAS negative emotions, mastery). Finally, participants were fully debriefed and NIC participants were offered to receive the ImRs intervention in an additional session for ethical reasons.

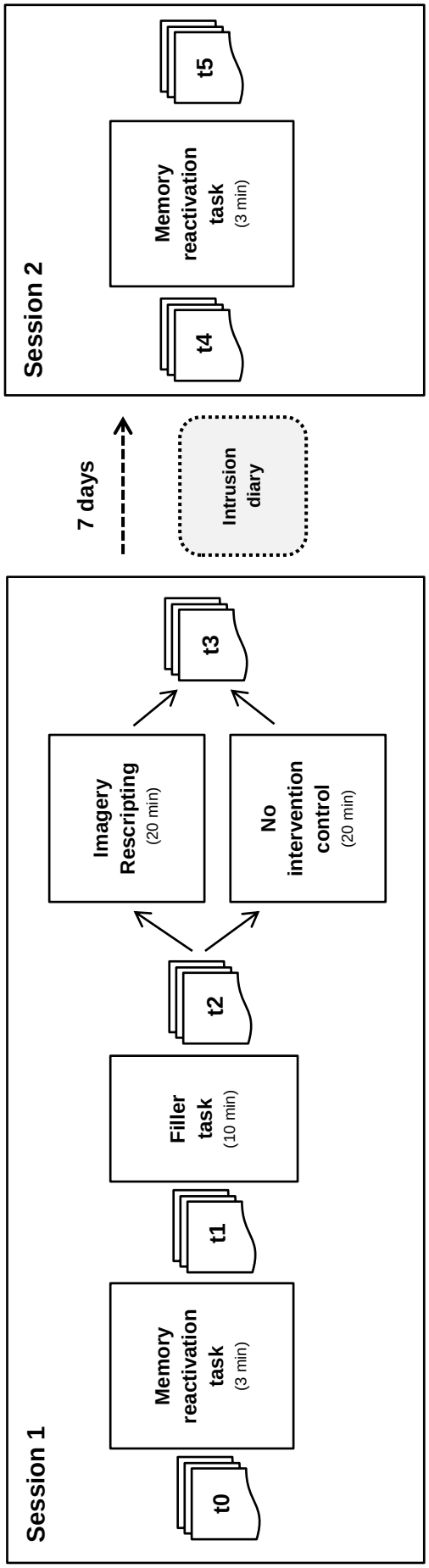

Figure 2.1. Schematic overview of the study procedure.
t0: M.I.N.I., structured interview on the distressing life-event, sociodemographic data, IES-R, intrusion questionnaire, PANAS, SUD, VAS negative emotions; t1: SUD, VAS negative emotions, mastery; t2: SUD, PANAS; t3: SUD, PANAS; t4: IES-R; t5: SUD, VAS negative emotions, mastery.

Statistical analyses

A manipulation check was performed to test effects of the memory reactivation task on subjective distress and negative emotions in both groups: For SUD ratings as dependent variable, a repeated measures analyses of variance (ANOVA) was conducted with Time (t0 vs. t1) as within-subject factor and Condition (ImRs vs. NIC) as between-subjects factor. For the six negative emotions, a 2(t0 vs. t1) x 2(ImRs vs. NIC) repeated measures multivariate analysis of variance (MANOVA) was carried out. Significant multivariate effects were followed up with separate ANOVAs on each emotion.

In order to test whether ImRs led to a greater reduction of event-related stress symptoms than NIC, 2 x 2 repeated measures ANOVAs with Time (t0 vs. t4) as within-subjects factor and Condition (ImRs vs. NIC) as between-subjects factor were carried out for the three subscales of the IES-R. Mann-Whitney *U*-tests were calculated to examine group differences between ImRs and NIC in intrusion frequency during the 1-week follow-up, given the positively skewed distribution of this variable. Effects of ImRs on memory distress, negative emotions and mastery were examined with separate 2 x 2 repeated measures ANOVAs with Time (t1 vs. t5) as within-subjects factor and Condition (ImRs vs. NIC) as between-subjects factor. To explore pre-post-effects of ImRs on affect and distress, a series of 2 x 2 repeated measures ANOVAs with Time (t2 vs. t3) as within-subjects factor and Condition (ImRs vs. NIC) as between-subjects factor were conducted.

A significance level of $\alpha = .05$ (two-tailed) was used for all analyses. One participant reported an implausibly high number of intrusions at baseline (100 intrusions during the past week), but was still included in analyses for Hypothesis 2, as results remained unchanged excluding this participant. Due to an interruption during the experimental procedure before post-treatment measurement, one participant of the ImRs group was not included in the exploratory analyses (pre vs. post effects).

Power analysis

Based on the main hypotheses regarding the effects of ImRs on event-related stress symptoms and reactions to memory reactivation, a sample-size calculation was run for the Time x Condition interaction effects (2x2 repeated measures ANOVA: within-between interaction, $\alpha = .05$, power = .80, run with G*Power 3.1). A sample size of 32 per group was required to detect small to medium interaction effects[2] ($f = 0.18$).

[2]As this is (to the best of our knowledge) the first controlled study investigating longer-term effects of ImRs on distressing autobiographical memories in a non-clinical sample, the assumed effect sizes could not be based on previously reported findings. We conservatively adjusted large effect sizes from clinical ImRs-studies (Morina et al., 2017) to small to medium effect sizes for our study.

Results

Participant characteristics and baseline comparisons

Participants' demographic characteristics, baseline measures as well as characteristics of the distressing life-events are provided in Table 2.1. There were no significant differences between ImRs and NIC in any of the measures. Baseline scores of outcome measures can be derived from Table 2.2. At baseline (t0) no significant differences between groups emerged on IES-R, PANAS, and SUD, all *p*s > .386.

Manipulation check: Effects of memory reactivation

As a manipulation check, we tested whether the memory reactivation led to the expected increase of subjective distress and negative emotions: The 2 (t0 vs. t1) x 2 (ImRs vs. NIC) repeated measures ANOVA revealed a significant main effect of Time with an overall increase in subjective distress (SUD) from pre- to post-memory reactivation, $F(1, 63) = 91.01$, $p < .001$, $\eta^2_p = .59$. No significant main effect of Condition and no significant interaction emerged, all *F*s(1, 63) < 0.55, *p*s > .460 , $\eta^2_p < .009$. Results of a 2 (t0 vs. t1) x 2 (ImRs vs. NIC) repeated measures MANOVA with the six negative emotions (anxiety, anger, sadness, shame, guilt, disgust) as dependent variables revealed a significant main effect of Time, $F(6, 58) = 13.22$, $p < .001$, $\eta^2_p = .58$. Neither the main effect of Condition, nor the interaction effect were significant, all *F*s(6, 58) < 0.37, *p*s > .897, $\eta^2_p < .037$. Separate univariate ANOVAs showed that there was an increase in all negative emotions over time, all *F*s(1, 63) > 7.56, *p*s < .008, $\eta^2_p > .11$, irrespective of condition. Nevertheless, mean levels of anxiety, anger, shame, guilt, and disgust were found to be still low after memory reactivation with 50% of the sample scoring under 20 on a 0-100 scale (see Figure A.1 in the Supplementary Material). As a consequence, only sadness was included as dependent variable in the main analysis as it seems questionable whether effects of ImRs can be investigated in the other emotions given their low levels.

Table 2.1. Sample characteristics and baseline comparisons

	Overall Sample (N = 65)	ImRs (n = 31)	NIC (n = 34)	Comparison between conditions
Gender (n female/male)	53/12	24/7	29/5	$\chi^2(1) = 0.67$, $p = .53$
Age in years: $M(SD)$	22.65 (2.90)	21.94 (2.98)	23.29 (2.71)	$t(63) = -1.93$, $p = .06$
Distressing life-event				
Time since event (in months): $M(SD)$, *range*	7.57 (5.95) 0.5 - 23	6.66 (6.01) 0.75 - 23	8.39 (5.86) 0.5 - 23	$t(63) = -1.17$, $p = .25$
Distress at time of the event: $M(SD)$	85.51 (12.63)	85.61 (12.23)	85.41 (13.17)	$t(63) = 0.06$, $p = .95$
Distress at beginning of study participation (t0): $M(SD)$	51.82 (15.47)	52.93 (15.49)	50.81 (15.63)	$t(63) = 0.55$, $p = .58$
Categories of the distressing life-events				
Relationship difficulties or break-ups	40%	39%	41%	
Serious illness of a close person	17%	22%	12%	
Family conflicts	12%	13%	12%	
Problems at university	11%	10%	12%	
Problems at work	6%	10%	3%	
Accidents	6%	0%	12%	
Other events	8%	6%	8%	
Intrusive memories (past 7 days)				
Number of intrusions: $M(SD)$	7.73 (13.40)	5.85 (6.08)	9.44[a] (17.56)	
Number of intrusions: *Mdn*	4.0	4.0	3.5	$U = 515.5$, $p = .88$
Intrusion distress: $M(SD)$	5.18 (2.05)	5.17 (2.12)	5.18 (2.02)	$t(60) = -0.02$, $p = .99$

Note. ImRs = Imagery rescripting; NIC = No-intervention control condition.

[a] There was an extreme outlier in NIC reporting 100 intrusive memories at baseline.

Effects on analogue symptoms

Event-related stress symptoms (Hypothesis 1)

Results of the 2 (t0 vs. t4) x 2 (ImRs vs. NIC) repeated measures ANOVAs revealed a significant main effect of Time for all three subscales of the IES-R, all *F*s(1, 63) > 16.00, *p*s < .001, η^2_p > .21, but neither significant main effects of Condition nor significant interactions, all *F*s(1, 63) < 1.96, *p*s > .166, η^2_p < .03. Contrary to the hypotheses, ImRs did not result in a stronger reduction of intrusions, avoidance, or hyperarousal assessed with the IES-R when compared to NIC (see Table 2.2).

Intrusive memories (Hypothesis 2)

The mean number of intrusive memories of the distressing life-event during the 1-week follow-up period was 2.45 (*SD* = 2.85; range 0-13). Participants in the ImRs group reported significantly fewer intrusions (*M* = 1.45, *SD* = 1.57; *Mdn* = 1.0) of the aversive memory targeted in this study than participants of the NIC group (*M* = 3.35, *SD* = 3.43; *Mdn* = 2.50), *U* = 359.0, *p* = .024, *r* = .28. On average, participants reported further 1.46 intrusions of other memories related to the life-event (*SD* = 2.44; range 0-11) with no differences between groups, *U* = 463.5, *p* = .359, *r* = .11. For frequencies of the different categories of intrusive memories per group see Table A.2 in the Supplementary Material.

Effects on emotional response to memory reactivation

Memory distress (Hypothesis 3)

The 2 (t1 vs. t5) x 2 (ImRs vs. NIC) repeated measures ANOVA for memory distress revealed no significant main effect of Condition, *F*(1, 63) = 0.92, *p* = .342, η^2_p = .01, but a significant main effect of Time, *F*(1, 63) = 75.92, *p* < .001, η^2_p = .55, as well as a significant interaction, *F*(1, 63) = 4.81, *p* = .032, η^2_p = .07. As predicted, ImRs led to a greater reduction of distress in response to the memory reactivation task than NIC (see Figure 2.2).

Memory-related negative emotions (Hypothesis 4)

As sadness was found to be the only relevant memory-related negative emotion (see manipulation check), intervention effects on emotional responses to the memory were only tested using sadness as a dependent variable[3]. The 2 (t1 vs. t5) x 2 (ImRs vs. NIC) repeated measures ANOVA revealed no significant main effect of Condition, $F(1, 63) = 0.37$, $p = .548$, $\eta^2_p = .01$, but a significant main effect of Time, $F(1, 63) = 16.89$, $p < .001$, $\eta^2_p = .21$, as well as a significant interaction, $F(1, 63) = 4.13$, $p = .046$, $\eta^2_p = .06$. As expected, ImRs reduced sadness in response to the memory reactivation task significantly stronger than NIC (see Figure 2.2).

Mastery (Hypothesis 5)

The results of the 2 (t1 vs. t5) x 2 (ImRs vs. NIC) repeated measures ANOVA for mastery as dependent variable are illustrated in Figure 2.2. The significant main effects of Time, $F(1, 63) = 24.98$, $p < .001$, $\eta^2_p = .28$, and Condition, $F(1, 63) = 4.31$, $p = .042$, $\eta^2_p = .06$, were qualified by a significant interaction, $F(1, 63) = 10.29$, $p = .002$, $\eta^2_p = .14$. As predicted, participants in the ImRs group reported significantly greater increases in mastery of the aversive situation in their memory.

Exploratory analyses: Pre vs. post effects on affect and distress

Results for positive affect revealed no significant main effect of Time (t2 vs. t3) or Condition (ImRs vs. NIC) nor a significant interaction, all Fs$(1, 62) < 0.40$, ps $> .529$, $\eta^2_p < .006$. For negative affect, a significant main effect of Condition was found, $F(1, 62) = 5.55$, $p = .022$, $\eta^2_p = .082$, but neither a significant main effect of Time nor a significant interaction, all Fs$(1, 62) < 2.08$, ps $> .154$, $\eta^2_p < .033$. Mean scores per condition are shown in Table 2.2. Results for subjective distress revealed a significant main effect of Time, $F(1, 62) = 18.85$, $p < .001$, $\eta^2_p = .23$, but no significant main effect of Condition nor a significant interaction, all Fs$(1, 62) < 1.19$, ps $> .279$, $\eta^2_p < .02$. There was an overall reduction in subjective distress from pre- to post-intervention, irrespective of experimental condition (see Table 2.2).

[3] Results of exploratory analyses on the other five emotions revealed that ImRs was superior to NIC in decreasing anger and guilt. Both conditions equally reduced shame. No changes were observed for disgust and anxiety. Detailed results are provided in Figure A.2 and Table A.1 in the Supplementary Material

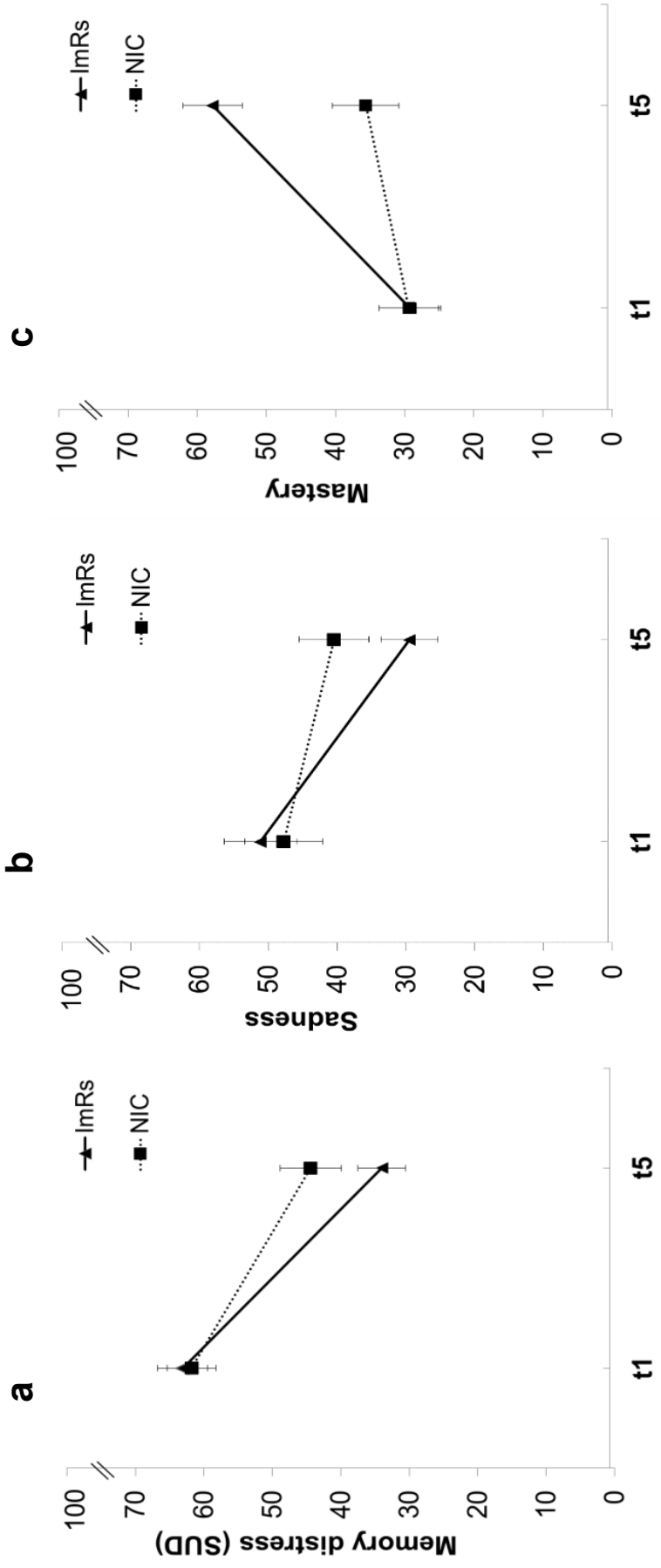

Figure 2.2. Effects of imagery rescripting (ImRs) vs. no-intervention control condition (NIC) on (a) memory distress, (b) sadness, and (c) mastery; t1: after memory reactivation task at baseline (before the intervention); t5: after memory reactivation task at follow-up (1 week after the intervention); Error bars represent SEM.

Table 2.2. Mean scores and standard deviations of outcome measures at baseline (t0), after memory reactivation 1 (t1), before (t2) and after (t3) the intervention, at follow-up (t4), and after memory reactivation 2 (t5).

	Group	t0	t1	t2	t3	t4	t5
		M (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
PANAS							
positive	ImRs	29.19 (7.14)		28.03 (8.30) [a]	27.50 (8.02) [a]		
	NIC	28.85 (5.08)		29.15 (7.49) [a]	28.47 (8.43) [a]		
negative	ImRs	17.03 (5.33)		15.20 (4.52) [a]	15.60 (6.74) [a]		
	NIC	16.82 (5.94)		13.59 (3.00) [a]	12.50 (2.97) [a]		
SUD	ImRs	40.35 (22.32)	63.10 (20.53)	39.73 (22.26) [a]	29.60 (21.06) [a]		33.97 (19.34)
	NIC	35.26 (24.45)	61.79 (20.90)	33.94 (21.71) [a]	24.68 (21.14) [a]		44.38 (26.13)
IES-R							
Intrusions	ImRs	15.29 (6.02)				10.97 (5.58)	
	NIC	14.38 (5.38)				11.68 (4.64)	
Avoidance	ImRs	13.48 (5.08)				10.97 (5.18)	
	NIC	14.56 (5.92)				12.82 (5.83)	
Hyperarousal	ImRs	9.10 (5.92)				5.55 (4.96)	
	NIC	9.38 (5.34)				6.12 (5.37)	

Note. ImRs = Imagery rescripting (*n* = 31); NIC = No-intervention control condition (*n* = 34); PANAS = Positive and Negative Affect Schedule; SUD = Subjective Units of Distress; IES-R = Impact of Event Scale-Revised

[a] *n* = 64

Discussion

To address limitations of previous ImRs studies using the TFP (e.g., Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012), the present study investigated ImRs in the context of personally relevant autobiographical emotional memories, which can be considered a better analogue for memories targeted with ImRs in clinical practice. The aims of the present study were to evaluate the usefulness of the adapted analogue paradigm in ImRs research and to conduct a preliminary examination of possible mechanisms underlying ImRs. Specifically, we investigated (1) whether ImRs reduces event-related stress symptoms, (2) whether ImRs leads to a change in meaning of the memory thereby decreasing memory distress and memory-related negative emotions, and (3) whether ImRs enhances feelings of mastery.

Evaluation of the paradigm: Effects on analogue symptoms

In order to evaluate the research paradigm, we tested whether the aversive autobiographical memories were associated with emotional distress and event-related stress symptoms, which could be modified through ImRs treatment. At the beginning of the study, participants still felt moderately distressed by the life-events and reported a mean number of six intrusive memories during the past week. Retrieving the memory of the distressing life-event during the reactivation task led to significant increases in subjective distress, fear, and non-fear emotions. However, only levels of sadness were found to be high after memory reactivation. This might be explained by the types of life-events reported by participants in our study. It is also possible that our procedure used for memory reactivation was not successful in activating all memory-relevant emotions. In order to examine effects on different emotional states, the paradigm needs to be modified, e.g. by focusing on specific types of life-events (related to specific emotions) or by intensifying emotional activation, e.g. through using mental imagery for the memory reactivation task (see Holmes & Mathews, 2010).

Contrary to our first hypothesis, ImRs was not superior to NIC in reducing event-related stress symptoms (i.e., intrusions, avoidance, and hyperarousal). This is surprising given that ImRs has been shown to effectively reduce posttraumatic stress symptoms in clinical studies (Morina et al., 2017). One possible explanation for this discrepancy might be that our ImRs intervention was adapted for the purpose of the analogue study, thus deviating from clinical

studies regarding the intervention protocol (i.e., participants were not instructed to experience the scene from the adult's and the child's perspective as often done in clinical practice, see Arntz & Weertman, 1999) and regarding treatment intensity (i.e., we conducted only one ImRs session with a mean duration of 18 min). Moreover, our experimental procedure might have had nonspecific therapeutic effects (e.g., mere attention, talking about the life-event in an appreciative atmosphere), leading to reductions of stress symptoms independently of group allocation.

In line with our second hypothesis, ImRs led to less intrusive memories of the distressing life-event than NIC during the week following the intervention. This finding extends results from recent laboratory studies on the preventive effects of ImRs on intrusion development (Dibbets & Arntz, 2016; Hagenaars & Arntz, 2012), by indicating that ImRs also has therapeutic effects on intrusion frequency of consolidated memories. Hence, we were able to successfully model treatment effects of ImRs on intrusive memories within the present paradigm. Interestingly, participants also reported some intrusions of memories that had not been explicitly targeted during study participation (i.e., during memory reactivation and ImRs), but were strongly related to their life-events. However, intrusion frequency of these memories did not differ between conditions. Due to floor effects, we might not have been able to detect potential treatment effects here. Surprisingly, although ImRs reduced intrusions of the memories targeted with the intervention (as measured via diaries), no treatment effects were evident on the Intrusion subscale of the IES-R. This discrepancy can most likely be explained by the different measurement approaches, as the retrospective assessment of intrusive memories with the IES-R can be expected to be more susceptible to memory biases than event-based immediate recording with diaries. It is also conceivable that participants rated the IES-R with respect to all event-related intrusive memories (including intrusions of memories that have not specifically been targeted within the study).

In order to more reliably model treatment effects on symptomatic outcomes, modifications of the paradigm are needed. This will be crucial for a systematic test of mechanisms underlying ImRs, i.e. for an examination of the relationship between the hypothesized mechanisms (e.g., memory processes) and symptomatic change. For this purpose, it would be useful to enhance treatment intensity and to increase baseline symptom severity, e.g. through including memories related to more severe events, which can be expected to be associated with higher symptom levels. An assessment of additional types of symptoms (e.g., rumination, depressive symptoms) might be also important, given that

sadness was the most important emotion in our sample. Furthermore, future studies should integrate measures of imagery ability, given recent evidence that outcomes of imagery interventions might be influenced by the ability to vividly visualize (McEvoy, Erceg-Hurn, Saulsman, & Thibodeau, 2015).

Examination of possible underlying mechanisms

In line with our hypotheses on possible treatment mechanisms, ImRs led to significantly larger reductions of distress and negative emotionality (sadness) in response to memory retrieval after one week compared to NIC. These findings replicate results of two earlier studies (Çili et al., 2016; Reimer & Moscovitch, 2015) and provide further evidence that ImRs reduces negative emotional responses associated with aversive memories. However, as sadness was the predominant emotion in our sample, results cannot be generalized to memories associated with other emotions. From a theoretical perspective, the reduced emotional response to the memory indicates that ImRs might work through a change in meaning of the aversive memory representation (Arntz, 2012). Here, the combination of reactivating the aversive memory content and then introducing new and more positive information through ImRs appeared to be crucial, as reactivation in combination with distraction (reading magazines) as done in NIC was not as effective. However, it is important to note that although our experimental procedure was designed to initiate memory reconsolidation processes (see James et al., 2015) we could not explicitly test whether ImRs indeed interfered with the reconsolidation of the original memory. It is also possible that ImRs works through creating an alternative memory representation, which then competes with the original aversive memory (see e.g., retrieval competition account by Brewin, 2006).

Future research should compare ImRs to other interventions that have been shown to successfully modulate aversive emotional memories, such as imaginal exposure treatment (e.g., Rothbaum & Schwartz, 2002) or eye movement desensitisation and reprocessing (EMDR; e.g., Lee & Cuijpers, 2013). Furthermore, it will be important to examine conditions under which ImRs most effectively changes aversive memories and the associated emotional responses (e.g., How and how long to reactivate? When to start the rescripting of the sequence of events?; see Dibbets & Arntz, 2016). In this regard, the introduced paradigm can be used to compare different variations of ImRs.

In line with our last hypothesis, ImRs participants reported greater increases in perceived mastery at 1-week follow-up than NIC participants. Our results imply that ImRs might have led to a revaluation of the memory content in terms of mastery. We specifically asked participants for an evaluation of controllability of the situation described during the memory reactivation task, i.e. for the original, not the rescripted sequence of events. Therefore, one might conclude that revaluation of the original situation has taken place in the ImRs group (see Arntz, 2012), potentially by enabling the individual to be in control of what is happening in their imagination, e.g., to defend one-self, to set boundaries, and to satisfy one's needs. In the context of PTSD it has been also discussed whether ImRs works through enhancing the ability to control intrusive images ("imagery control") (Long & Quevillon, 2009). It is important to further investigate which elements of mastery can be changed through ImRs and whether the intervention might be beneficial to increase overall feelings of mastery, i.e. mastery of aversive events (as measured in our study), mastery of intrusive symptoms (e.g., Germain, 2004; Long & Quevillon, 2009), and mastery in difficult interpersonal situations. Finally, more research is needed to clarify whether enhanced mastery after ImRs is indeed associated with symptomatic change. Future studies are recommended to include more reliable measures of mastery.

Exploratory analyses

ImRs and NIC both reduced distress from pre- to post-intervention, but no changes in positive or negative affect emerged. Although ImRs entails intense confrontation with aversive memory contents, it seems to have equivalent short-term effects on distress and affect as mere distraction, pointing towards potential benefits of ImRs as a more tolerable treatment method compared to established exposure-based therapies (see also Siegesleitner, Strohm, Wittekind, Ehring, & Kunze, 2019a). To further investigate this assumption, future studies should include an additional exposure-based control condition.

Limitations

Results of the present study have to be interpreted in light of the following limitations: As our design did not include an active control condition, it currently remains unclear whether effects are specific to ImRs treatment or whether results could partially be explained by the

greater degree of exposure to memory content in the ImRs group. Future studies should compare ImRs to other interventions as well as to active experimental control conditions (e.g., to control for the duration of exposure to memory content, interaction with the experimenter, working memory load, or positive imagery).

Our intervention protocol deviated from ImRs treatment as used in clinical practice regarding the additional memory reactivation task before the intervention starts (in patients the memory is emotionally activated only once in the first phase of the ImRs), thus limiting the generalizability of results to clinical settings. Moreover, we did not explicitly encourage participants to experience the memory from the younger vs. the older self's perspective as typically done in clinical protocols (e.g. Arntz & Weertman, 1999; Wild & Clark, 2011). Until now, ImRs variations with and without such perspective taking have not been systematically compared regarding their therapeutic efficacy. Although findings from our study indicate that ImRs without perspective taking changes the meaning of autobiographical memories in healthy participants, it is possible that in patients with more severe or traumatic memories perspective taking is necessary for therapeutic success. Viewing earlier experiences from an adult's perspective enables patients to self-distance and thus it might be particularly helpful to question maladaptive beliefs and to generate alternative meanings. In order to model processes underlying ImRs treatment as it is typically employed in patient samples, future analogue research is recommended to adopt clinical protocols (i.e. ImRs with perspective taking).

With respect to findings from a lab study by Dibbets and Arntz (2016) showing that ImRs may be more effective when the participant's individual hotspot of the memory is included, we initiated the rescripting of the memory immediately after the hotspot (preventing the hotspot during ImRs was therefore not possible). However, it remains an open question whether this procedure is also more effective in clinical settings. Alternatively, activated emotional arousal and the expectation of the upcoming trauma may suffice for initiating the rescripting in patient populations, allowing that parts of the traumatic events are prevented/undone (see e.g., Arntz, 2015; Arntz & Weertman, 1999). Additional research is needed to clarify these issues.

For practical reasons, we assessed baseline intrusion frequency retrospectively via questionnaires (overall estimate of numbers of intrusive memories), whereas intrusive memories during the week after the intervention were recorded day by day in an intrusion diary (allowing us to specifically analyze intrusions of the memory targeted in the study).

Given these different measurement approaches, a direct comparison between the numbers of intrusive memories at baseline and during the follow-up period was not possible and we were not able to control for baseline numbers of intrusive memories as measured with the diary. Consequently, group differences in intrusive memory frequency after the intervention can only carefully be interpreted as an effect of ImRs and future studies are recommended to include intrusion diaries in the week both before and after the interventions. Moreover, it is important to note that we did not only include image-based intrusive memories in the coding procedure, but also memories rated as "thoughts" by participants. This limits comparability of results to studies that restricted their analyses to intrusive images. Additionally, future studies should not only measure intrusive memories during the follow-up interval, but also intentional recollections of the targeted memories and/or the new images developed during the interventions, as this may influence the long-term outcome of the intervention. This appears especially informative as patients often receive homework assignments to intentionally think back to the reactivated memories to improve treatment effects.

We only included life-events that had happened within the past 24 months, limiting generalizability of our results to older memories that have been argued to be less prone to change than more recent memories (Alberini, 2011). Although experimenters did not provide a rationale for ImRs and did not refer to ImRs as "intervention" or "treatment", placebo effects of the imagery exercise cannot be completely ruled out. Finally, as we used a healthy and largely female student sample, results of the present study cannot be generalized to clinical populations or more heterogeneous samples (with respect to age, gender, and education).

Conclusion

In conclusion, the present findings support the suitability of the adapted paradigm to systematically investigate the effects of ImRs in autobiographical emotional memories. The analogue procedure used in this study might be especially promising for research into memory processes involved in ImRs. In order to more reliably model treatment effects on analogue symptoms, it would be useful to increase baseline symptom severity and to enhance treatment intensity. Furthermore, it will be crucial to integrate active control conditions. The results of this study show that ImRs reduces intrusion frequency of aversive autobiographical memories, decreases memory-related emotional distress, and enhances feelings of mastery. In

sum, our findings underline the potential of ImRs as a transdiagnostic intervention in the treatment of psychopathology associated with aversive emotional memories.

3. Study II:

Imagery Rescripting of Aversive Autobiographical Memories: Psychological and Physiological Effects

Abstract

Imagery rescripting (ImRs) is a promising intervention to reduce symptoms associated with aversive memories, but little is known about its working mechanisms. The present study investigates whether ImRs increases perceived mastery and attenuates emotional reactivity to memory retrieval on a subjective and physiological level. Seventy-nine individuals reporting memories of distressing real-life events were randomly allocated to ImRs, positive imagery (PI) or no-intervention control (NIC). The memory was reactivated before the intervention and at 1-week follow-up to assess subjective measures and physiological reactivity (heart rate [HR], skin conductance level [SCL], and facial electromyography activity [EMG]) during memory retrieval. ImRs was not superior to PI and NIC in increasing perceived mastery, but ImRs participants reported stronger reductions in subjective memory distress and negative emotionality (helplessness). Physiological reactivity (HR, EMG) was attenuated at follow-up with no differences between groups. Findings challenge the notion that changing perceived mastery is essential to reduce subjective emotional reactivity to aversive memories with ImRs. It needs to be tested, how findings from this laboratory study translate to ImRs for traumatic memories.

Introduction

Imagery rescripting (ImRs) is a promising imagery-based treatment strategy to target aversive memories in emotional disorders (Morina, Lancee, & Arntz, 2017). During ImRs, a memory is first emotionally activated using imagery. In a second step, patients are encouraged to change negative mental images of the distressing event into more positive outcomes according to their individual needs (Arntz, 2012; Holmes, Arntz, & Smucker, 2007). Despite growing evidence for the efficacy of ImRs to reduce symptoms associated with aversive memories in different disorders (for a meta-analysis, see Morina et al., 2017), relatively little is known about the mechanisms underlying symptomatic change.

A seminal theory on the nature of traumatic memories suggests that traumatic events are stored in associative memory networks in which information about the aversive stimulus situation is stored together with information about the meaning of the event, and about the verbal, behavioral, and physiological responses shown in response to the event (see Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989; Lang, 1979). The model furthermore states that in order to foster emotional processing, which results in a reduction of memory-related emotional and physiological responding, the memory representation first needs to be activated; secondly, new information that is incompatible with the existing memory structure then needs to be incorporated (Foa & Kozak, 1986; Foa et al., 1989). Emotional processing theory in the context of posttraumatic stress disorder (PTSD) was originally developed by Foa and colleagues (1986; 1989) as a rationale for prolonged exposure treatment, whereby within-session habituation to fear is regarded as an important component of corrective information that is integrated into the memory network. However, other interventions, such as ImRs, may be alternative means to first activate aversive memory structures and to then integrate corrective information (see e.g., Hackmann, 2011). Importantly, during ImRs corrective information is induced more explicitly, for example by generating mental images of the self as being competent and powerful or in control of what is happening. In this way, ImRs provides new meanings targeting dysfunctional beliefs typically experienced by patients with trauma-related disorders (e.g., of the self as being incompetent/helpless/incapable; see Foa & Rothbaum, 1998; Ehlers & Clark, 2000). In line with emotional processing theory, Arntz (2012) suggested that ImRs treatment works by activating aversive memories and then providing alternative meanings such that the memory representation of the aversive event is stored with a different and less negative meaning. This, in turn, should lead to reductions in memory-related negative emotional responses (Arntz, 2012).

There is preliminary evidence supporting the view that ImRs works by changing the meaning of memory representations. In laboratory-based analogue studies, ImRs has been shown to modify the negative valence of memories of aversive film/picture stimuli and to reduce associated negative emotional responding (Dibbets, Lemmens, & Voncken, 2018; Dibbets, Poort, & Arntz, 2012; Hagenaars & Arntz 2012). Moreover, there is evidence that ImRs might specifically work by fostering perceived mastery in the face of aversive experiences. Participants who had experienced distressing life-events appraised the originally distressing experience as being more controllable after ImRs indicating that the intervention had led to a revaluation of the aversive autobiographical memory contents (Strohm, Siegesleitner, Kunze, Ehring, & Wittekind, 2019). The beneficial effects of ImRs on perceived mastery may be due to the fact that during ImRs individuals are led to actively change the sequence of events according to their individual needs and to express action tendencies that had been inhibited in the original situation, such as defending oneself and disempowering the perpetrator (Arntz, 2012). In patients with nightmare disorder, perceived mastery (of the nightmare content) has been found to mediate the beneficial effects of ImRs; importantly, this mediation only emerged in the ImRs condition and was not observed in individuals receiving imaginal exposure treatment (Kunze, Lancee, Morina, Kindt, & Arntz, 2019). This indicates that enhancing mastery might be a working mechanism that is rather specific for ImRs.

In addition, there is evidence that ImRs attenuates negative emotional responding to autobiographical memories. Specifically, ImRs reduced negative emotions and distress triggered by memories of aversive life-events that were retrieved following the intervention (Cili, Pettit, & Stopa, 2016; Nilsson, Lundh, &Viborg, 2012; Reimer & Moscovitch, 2015; Strohm et al., 2019). However, one limitation of the latter studies is that emotional responding to the memories was only assessed on a subjective level. If ImRs indeed modifies memory representations of distressing events such that the memory is stored with a less negative meaning, memory-related physiological responding should be reduced in addition to reductions of subjectively reported emotional responding to the memory (Arntz, 2012; see also the emphasis on physiological responding as an indicator of successful emotional processing in emotional processing theory: Foa et al., 1989). However, until now only few studies have included physiological outcome measures in the context of ImRs research.

Findings from recent experimental studies using fear conditioning paradigms are inconclusive with respect to the effects of ImRs on physiological responding to conditioned

stimuli (Dibbets et al., 2018; Dibbets et al., 2012; Kunze, Arntz, & Kindt, 2019). In participants with increased health anxiety, ImRs (as well as imagery re-experiencing) yielded higher physiological activation (heart rate [HR]) during the intervention when compared to a positive imagery and a no intervention control condition (Tolgou et al., 2018). Moreover, there was a trend for ImRs yielding the greatest HR reductions during the intervention, possibly indicating successful emotional processing (Tolgou et al., 2018). In patients with social anxiety disorder (SAD), ImRs was found to selectively attenuate physiological reactivity (HR parameters) to a speech task when compared to verbal restructuring and a waitlist control condition, but the ImRs group was more reactive to the speech task after treatment indexed by skin conductance (Hyett et al., 2018). Taken together, there is preliminary evidence that ImRs leads to physiological activation during the intervention and reduces physiological responding to relevant stressors, but it has not been specifically examined whether ImRs attenuates the physiological reactivity to aversive autobiographical memories retrieved following treatment.

The aim of the present study was twofold: First, it was aimed to replicate previous findings that ImRs leads to a revaluation of distressing memory contents regarding perceived mastery (Kunze et al., 2019; Strohm et al., 2019) and reduces self-reported negative emotional responses to memory retrieval (Cili et al., 2016; Nilsson et al., 2012; Reimer & Moscovitch, 2015; Strohm et al., 2019). Second, it was aimed to extend previous research by examining whether ImRs changes physiological responding to memories of aversive life-events and whether increases in perceived mastery are associated with changes in emotional responding.

The present study was based on an analogue paradigm used by Strohm et al. (2019). In this earlier study, the effects of ImRs versus a no intervention control group (NIC) were examined in healthy individuals reporting aversive memories of distressing real-life events. Subjective responses to memory retrieval were assessed before the intervention and at 1-week follow-up. In the current study, the design of this earlier study was extended by including (a) physiological measurements in addition to subjective reports and (b) a positive imagery condition (PI) as an additional active control condition. This second control condition was included to control for the effects of activating a memory representation in combination with inducing positive mental images, emotions, and meanings but without changing meaning-relevant contents of the original aversive memory.

First, ImRs was expected to be superior to both control conditions in reducing subjective distress associated with the aversive life-event during the follow-up period and in reducing stress symptoms elicited by memory retrieval (re-experiencing, avoidance, dissociation). Second, in line with the proposed working mechanism and based on previous findings, ImRs was expected to be superior to PI and NIC in enhancing perceived mastery and in decreasing negative emotions, distress, and arousal in response to memory retrieval. Moreover, it was hypothesized that ImRs would yield stronger increases in self-reported positive emotions in response to memory retrieval. Third, ImRs was assumed to lead to stronger reductions in physiological arousal, indexed by HR and skin conductance level (SCL), as well as negative emotional valence, indexed by facial electromyography activity (EMG), in response to memory retrieval. Finally, the effects of ImRs, PI, and NIC on physiological recovery from retrieval of the aversive memory were explored.

Method

Participants

Individuals who had experienced a distressing life-event in the past 24 months (e.g., relationship break-up, job loss, bullying, interpersonal conflicts) were recruited via social media and on university campus. Participants had to meet the following inclusion criteria: (1) experience of a distressing but non-traumatic life-event (i.e., not meeting criterion A of DSM-5, American Psychiatric Association, 2013) within the past 24 months, (2) subjective distress of at least 50 (on a 0-100 scale, ranging from *not at all distressed* to *extremely distressed)* at the time the event happened, (3) distress of at least 30 (on the same 0 – 100 scale) at the time of study participation, and (4) recurrent distressing memories of the life-event in the form of (a) intrusive thoughts or images, (b) nightmares or (c) emotional/physiological responding to reminders of the event. Individuals reporting a case of death as their life-event were excluded due to ethical concerns. Moreover, individuals who met the following criteria were excluded: (1) current diagnosis of a mental disorder (including acute suicidal tendencies), (2) lifetime diagnosis of PTSD/ psychotic disorder/ bipolar disorder, (3) psychological treatment at the time of study participation, (4) severe physical illness, (5) pregnancy, and (6) age below 18 or above 35 years. All inclusion and exclusion criteria were assessed in Session 1 using a short structured screening interview and the German version of the Mini International Neuropsychiatric Interview for DSM-5 (M.I.N.I. 7.0.2; Sheehan et al., 1998; Sheehan, 2016). Fifteen individuals had to be excluded from participation (n = 7 reported a life-event not meeting inclusion criteria; n = 7 met criteria for a current or lifetime diagnosis of the mental disorders specified above), leaving a total sample of 79 students included in this study (age: M = 24.20, SD = 3.84; 83.5% female). Ethical approval was obtained from the Ethics Committee at LMU Munich. Participants received either partial course credit or 22€. All participants gave written informed consent.

Memory reactivation task

In both sessions, a memory reactivation task was used to measure self-reported and physiological responses to memory retrieval. First, the most distressing "scene" of the life-event was determined in order to get a specific memory for the memory reactivation task (and subsequently for ImRs). Additionally, participants were asked to indicate the most aversive

moment within this "scene" to specify the individual hotspot. The memory reactivation task comprised two phases: During Phase 1, participants were instructed to close their eyes and to vividly imagine the specified memory focusing on all sensory modalities and emotions. They were asked to describe the event as if it was happening right now in the first person perspective and in present tense. Phase 1 of memory reactivation ended with the participant imagining the individual hotspot (mean duration of Phase 1 was 3.96 min [*SD* = 1.64] in Session 1 and 3.13 min [*SD* = 0.71] in Session 2). Participants were then administered self-report measures on responses to memory retrieval. For Phase 2 of memory reactivation, participants were instructed to close their eyes and to vividly imagine the hotspot of their memory for one minute (without talking) and to be aware of upcoming emotions. This phase was used for an additional recording of physiological responses to memory retrieval without talking, given that physiological reactions have been shown to be influenced by changes in respiration patterns during speech (see Beda, Jandre, Phillips, Giannella-Neto, & Simpson, 2007; Quintana & Heathers, 2014).

Experimental conditions

Imagery rescripting

In the ImRs condition, participants were first instructed to vividly imagine the aversive memory specified before and to describe it in detail from the first person perspective and in present tense, as if the event was happening at that moment. Participants were encouraged to focus on all sensory modalities, feelings, and body sensations. This first phase of the intervention aimed to reactivate memory-related emotions (duration: *M* = 3.41 min, *SD* = 1.15) and it ended with the participant holding the image of the individual hotspot in mind. The rescripting of the memory (duration: *M* = 11.26 min, *SD* = 2.97) was then initiated and participants were asked to change the course of the event in any desired way to make it less distressing (changes could be realistic or unrealistic). They were encouraged to imagine the new script as vividly as possible and to describe it in detail. During the rescripting of the memory, the following questions were asked to support participants (see Arntz & Weertman, 1999): *What would you like to do/say? Ok, do it/say it! What do you feel? What do you think? Is there anything else you would like to change? Is there anything (else) you need?*. When participants did not wish to include further changes but were satisfied with the new outcome,

they were asked to stay for a moment with the final positive image before concluding the imagery exercise.

Positive imagery

Participants were asked to vividly imagine a positive event of the past 24 months and to describe it to the experimenter in the first person perspective, present tense, focusing on body sensations and emotions (duration: *M* = 9.2 min, *SD* = 1.45). The positive event had to be unrelated to the distressing life-event. Participants rated the positive events as highly pleasant (time of the event: *M* = 93.64, *SD* = 8.44; time of study participation: *M* = 89.00, *SD* = 11.55; 0-100 scale, ranging from *not at all pleasant* to *extremely pleasant).*

No-intervention control condition

Participants were provided neutral magazines and were asked to wait 20 minutes in the laboratory.

Self-report measures

Depressive symptoms

The Patient Health Questionnaire-9 Item (PHQ-9; Krönke, Spitzer, & Williams, 2001; German version: Löwe, Spitzer, Zipfel, & Herzog, 2002) was administered to test for baseline differences in depressive symptoms. The PHQ-9 is a reliable and valid measure of depression severity (Krönke et al., 2001; internal consistency in the present study: Cronbach's $\alpha = .83$).

Event-related distress

In order to assess intervention effects on distress related to the life-event, participants were asked how distressed they felt by the life-event during the past week on a 100-mm visual analogue scale (VAS) ranging from 0 (*not at all distressed*) to 100 (*extremely distressed*).

Mastery

After memory reactivation, perceived mastery was assessed by asking participants to verbally indicate how controllable they experienced the situation that they had just imagined, on a scale ranging from 0 (*not at all controllable*) to 100 (*very controllable*).

Emotions

In order to assess memory-related emotional reactions 100-mm VAS for five negative (*anxious, angry, sad, guilty, helpless*) and three positive emotions (*happy, satisfied, proud*) were administered after memory reactivation (and at baseline). Participants were instructed to indicate how they felt at the moment on a scale ranging from 0 (*not at all*) to 100 (*extremely*). The distinct emotions were presented in the same order in both sessions (as listed above).

Self-reported arousal

Subjective physiological arousal was assessed after memory reactivation (and at baseline) using self-assessment manikins (SAM; Bradley & Lang, 1994). On a scale ranging from 1 (*very calm*) to 9 (*very aroused*) participants were asked how aroused they felt at the moment.

Memory distress

Memory distress was assessed verbally after memory reactivation using Subjective Units of Distress (SUD). Participants were asked to indicate how distressed they felt at the moment on a scale ranging from 0 (*not at all distressed*) to 100 (*extremely distressed*).

Stress symptoms

The Response to Script Driven Imagery Scale (RSDI; Hopper, Frewen, Sack, Lanius & van der Kolk, 2007) was used to measure stress symptoms evoked by mental imagery of the aversive memories on three subscales: re-experiencing (4 items), avoidance (3 items), and dissociation (3 items), with a scale ranging from 0 (*not at all*) to 6 (*a great deal*). In the present study instructions of the RSDI were adapted to measure responses to the memory reactivation task, which was not script-driven. Mean subscale scores were computed to facilitate comparison between scales (see Hopper et al., 2007). The RSDI has demonstrated good psychometric properties (Hopper et al., 2007; internal consistencies in the present study: Cronbach's α's = .59 - .83).

Physiological measurement

Physiological activity was recorded using a stationary system for psychophysiological measurements (Refa; Twente Medical Systems International [TMSi], EJ Oldenzaal, The

Netherlands) and the recording software package Polybench 1.30 (TMSi). The sampling rate was 1024 Hz. A wet band on the left wrist served as grounding for all channels. Recorded data were further processed using the software Autonomic Nervous System Laboratory (ANSLAB) version 2.6 (Blechert, Peyk, Liedlgruber, & Wilhelm, 2015). Physiological activity before the memory reactivation task (1 min resting baseline), during memory reactivation (Phase 1: imagination with *verbal narrative of the life-event*; Phase 2: *imagination of the hotspot* without talking), and after memory reactivation (2 min. recovery phase) was included for analyses; for each of these experimental periods, mean scores of HR, SCL, and EMG were computed.

Heart rate (HR)

Electrocardiography (ECG) was used to measure cardiovascular activity (HR in beats per minute [bpm]) as an index for physiological arousal (Mauss & Robinson, 2009). ECG electrodes were applied on the upper sternum and lowest rib on the left side. A 0.05 Hz highpass filter was applied during ECG measurement. Raw data were bandpass filtered between 0.5 and 40 Hz (Wilhelm, Grossman, & Roth, 1999). For further processing, the software ANSLAB 2.6 (Blechert et al., 2015) was used to automatically determine R-spikes, which were subsequently manually checked.

Skin conductance level (SCL)

SCL was also assessed as an index for physiological arousal (Mauss & Robinson, 2009). Electrodermal activity was obtained by applying a constant voltage (0.5V) between the index and middle finger of the non-dominant hand, using an isolated electrodermal amplifier module supplied by Becker Meditec (Karlsruhe, Germany) and Ag/AgCl electrodes with 5-mm inner-diameter, filled with isotonic paste (TD-246, MedCat, Germany). Mean SCL in µS was computed and fluctuations with an increase larger than 0.02 µS were considered a response.

Electromyography (EMG)

In order to measure the valence of participants' emotional states during memory reactivation, facial muscle activity of the *m. corrugator supercilii* was assessed (see Mauss & Robinson, 2009) by one pair of 2-mm inner-diameter Ag/AgCl electrodes, that were placed with centers approximately 1 cm apart above the participant's right eye-brow (Fridlund & Cacioppo, 1986). EMG preprocessing using ANSLAB 2.6 comprised a 28 Hz high-pass filter,

50 Hz notch filter, rectification, low pass filtering (15.92 Hz) and 50 ms moving average filter.

Procedure

The study consisted of two sessions with seven days in between the sessions. Both sessions took place at the same time of the day. Questionnaires were administered digitally (unless otherwise specified in 2.4) using the online platform *Unipark*® and *Eprime.* For an overview of the study procedure see Figure 3.1.

Session 1

First, screening interviews were administered to assess inclusion and exclusion criteria. After study inclusion, electrodes for physiological measurements were attached and participants then filled out baseline questionnaires (t0: sociodemographic data, PHQ, event-related distress, emotions, self-reported arousal) and were provided a demonstration of an imagery exercise by the experimenter (imagination of today's breakfast). This was followed by a 1-min baseline assessment of HR, SCL, and EMG. Next, the memory reactivation task was administered that included self-report measures referring to memory reactivation Phase 1 (t1: mastery, emotions, self-reported arousal, memory distress) and the two phases of physiological measurement described above. After memory reactivation, participants were instructed to relax for two minutes (recovery phase), followed by the RSDI (t2). After a 10-min break, participants were randomly allocated to ImRs (n = 27), PI (n = 25) or NIC (n = 27) using a computer-generated allocation sequence. Groups were stratified by gender. The experimenter was blind to condition until the beginning of the interventions.

Session 2

Participants first filled out baseline questionnaires (t3: event-related distress, emotions, self-reported arousal), followed by a 1-min baseline assessment of HR, SCL and EMG. Next, the memory reactivation task was administered using the same memory and the same procedure as in Session 1 (including t4: mastery, emotions, self-reported arousal, memory distress, and physiological measurement Phases 1 and 2). After a 2-min recovery phase, participants filled out RSDI (t5). Finally, participants were fully debriefed.

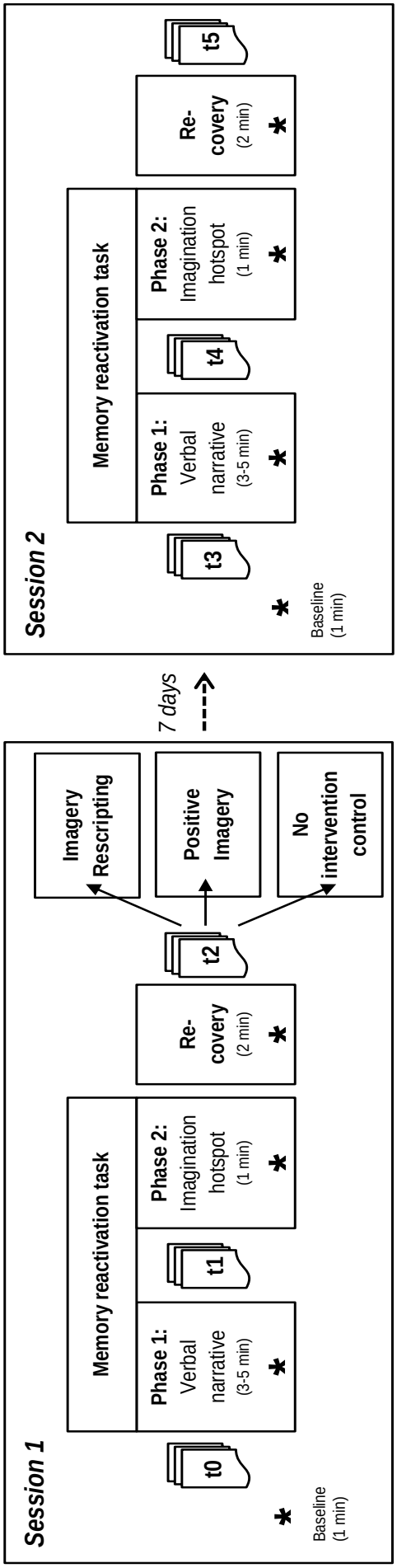

Figure 3.1. Schematic overview of the study procedure.
* = Physiological measurement phases; t0: sociodemographic data, PHQ, event-related distress, emotions, self-reported arousal; t1: emotions, self-reported arousal, memory distress, mastery; t2: RSDI; t3: event-related distress, emotions, self-reported arousal; t4: emotions, self-reported arousal, memory distress, mastery; t5: RSDI.

Statistical analyses

A manipulation check was carried out to test effects of the memory reactivation task on subjective and physiological responses during Session 1 using 2(Time) x 3(Condition) repeated measures analyses of variance (ANOVAs) for self-reported arousal, HR, SCL, EMG and two repeated measures multivariate analyses of variance (MANOVAs) for negative and positive emotions as dependent variables.

Main analyses for event-related distress, memory distress, mastery, and RSDI, comprised a series of 2(Time) x 3(Condition) repeated measures ANOVAs. For emotions and self-reported arousal, reactivity scores (Session 1: t1 – t0; Session 2: t4 – t3) were computed and hypotheses were tested using 2(Time) x 3(Condition) repeated measures ANOVAs on reactivity scores. For physiological measures, reactivity and recovery indices were computed for both sessions (see Hyett et al., 2018). Reactivity was defined as the difference between baseline physiological activity and activity during the first minute of memory reactivation Phase 1 (*imagination with verbal narrative of the life-event;* reactivity = mean memory reactivation Phase 1 - mean baseline) or Phase 2 (*imagination of the hotspot without talking;* reactivity = mean memory reactivation Phase 2 - mean baseline), respectively. Recovery was defined as the difference between baseline physiological activity and activity during the last minute of recovery (i.e., mean recovery - mean baseline). A series of 2(Time) x 3(Condition) repeated measures ANOVAs was conducted for reactivity and recovery scores of HR, SCL, and EMG. For self-report and physiological measures, significant interaction effects were followed up using planned contrasts on change scores (Session 2 – Session 1) to test for differences between ImRs and the control conditions (ImRs vs. PI+NIC) as well as between ImRs and PI. Partial eta squared (η^2_p) or Cohen's *d* were used as effect sizes and criterion of significance was set at $\alpha = .05$ (two-sided) for all analyses.

Due to technical problems, physiological data of three participants were not recorded (*n* = 1 ImRs; *n* = 2 NIC) and data for single measurement phases were missing in four participants in Session 1 and one participant in Session 2. Self-report measures were erroneously not administered in some participants (*n* = 1 for RSDI, emotions, arousal; *n* = 2 for event-related distress). These participants were excluded from the respective analyses.

Results

Sample characteristics and baseline comparisons

There were no significant differences between conditions on sociodemographic and baseline measures (see Table 3.1).

Manipulation check

For self-reported arousal, there was an overall increase from pre- to post-memory reactivation (t0 vs. t1) during Session 1, $F(1, 75) = 183.35$, $p < .001$, $\eta^2_p = .71$, with no differences between conditions, all Fs$(2, 75) < 0.60$, ps $> .552$, η^2_ps $< .02$. Levels of negative emotions increased from pre- to post-memory reactivation (t0 vs. t1), whereas levels of positive emotions decreased, all Fs$(5, 71 / 3, 73) > 33.39$, ps $< .001$, η^2_ps $> .70$, with no differences between conditions, all Fs$(10, 144 / 6, 148) < 1.03$, ps $> .419$, η^2_ps $< .07$ (see Table 3.2).

The manipulation check for physiological measures revealed an increase in HR from baseline to both phases of memory reactivation, all Fs$(1, 71 /1, 72) > 13.48$, ps $< .001$, η^2_ps $> .16$. Additionally, groups differed significantly in their overall HR levels, all Fs$(2, 71 /2, 72) > 6.48$, ps $< .003$, η^2_ps $> .15$, with ImRs participants showing the highest mean HR across time points. However, there were no significant Time x Condition interaction effects, all Fs$(2, 71/ 2, 72) < 2.48$, ps $> .091$, η^2_ps $< .06$. While SCL increased from baseline to memory reactivation Phase 1 (*imagination with verbal narrative*), reductions in SCL emerged from baseline to memory reactivation Phase 2 (*imagination of hotspot*), all Fs$(1, 71 /1, 72) > 4.43$, ps $< .039$, η^2_ps $> .06$, with no differences between groups, all Fs$(2, 72/ 2, 71) < 1.35$, ps $> .267$; η^2_ps $< .04$. EMG activity only increased in response to memory reactivation Phase 2, $F(1, 71) = 23.12$, $p < .001$, $\eta^2_p = .25$, but not in response to memory reactivation Phase 1, $F(1, 71) = 0.27$, $p = .605$, $\eta^2_p < .01$, with no differences between groups, all Fs$(2, 71) < 0.89$, ps $> .416$; η^2_ps $< .02$. Therefore, only the EMG reactivity score for Phase 2 (*imagination of the hotspot*) was included in the main analyses.

Table 3.1. Sample characteristics and baseline comparisons

	Overall Sample (N = 79)	ImRs (n = 27)	PI (n = 25)	NIC (n = 27)	Comparison between conditions
Gender (n female/male)	66/13	22/5	22/3	22/5	$\chi^2 = 0.59$, $p = .802$
Age in years: M (SD)	24.20 (3.84)	23.96 (4.02)	23.24 (3.11)	25.33 (4.11)	$F(2,78) = 2.06$, $p = .135$
Time since life-event (in months): M (SD)	7.67 (6.51)	6.85 (5.44)	8.87 (6.94)	7.37 (7.15)	$F(2,78) = 0.66$, $p = .520$
SUD time of the event: M (SD)	87.66 (9.25)	88.63 (8.22)	84.88 (10.00)	89.26 (9.27)	$F(2,78) = 1.71$, $p = .188$
SUD beginning of study participation: M (SD)	51.98 (18.46)	52.22 (17.06)	48.60 (18.12)	54.89 (20.21)	$F(2,78) = 0.75$, $p = .475$
Categories of the distressing life-events					
Relationship difficulties or break-ups	54%	59%	52%	55%	
Family conflicts	10%	7%	12%	8%	
Problems at work, bullying	9%	11%	4%	11%	
Problems at university	8%	0%	16%	8%	
Accidents	8%	11%	4%	8%	
Serious illness of a close person	3%	0%	4%	3%	
Other events	8%	11%	8%	8%	
Depressive symptoms (PHQ-9): M (SD)	15.72 (4.78)	14.23 (4.60)	15.76 (4.78)	17.24 (5.19)	$F(2,75) = 2.64$, $p = .078$

Note. ImRs = Imagery rescripting; PI = Positive imagery; NIC = No-intervention control condition; SUD = Subjective Units of Distress; PHQ-9 = Patient Health Questionnaire-9.

Subjective outcomes

Event-related distress

Conditions differed in baseline to follow-up changes of distress related to the life-event as indicated by a significant Time x Condition interaction, $F(2, 74) = 4.26$, $p = .018$, $\eta^2_p = .10$. Planned contrasts revealed stronger reductions in distress from Session 1 to Session 2 in ImRs compared to the control conditions (PI+NIC), $t(74) = -2.80$, $p = .007$, $d = 0.68$, with ImRs yielding stronger decreases than PI, $t(74) = 2.84$, $p = .006$, $d = 0.80$ (see Figure 3.2).

Mastery

Increases in perceived mastery from Session 1 to Session 2 were evident, $F(1, 76) = 14.62$, $p < .001$, $\eta^2_p = .16$, with no differences between conditions, all Fs$(2, 74/\ 2, 76) < 0.85$, $p > .432$, η^2_ps $< .02$ (see Figure 3.2).

Emotions

Pre- and posttreatment reactivity scores per condition are provided in Table 3.2. For helplessness, changes in reactivity differed significantly between groups as indicated by a significant Time x Condition interaction, $F(2, 75) = 5.14$, $p = .008$, $\eta^2_p = .12$. Planned contrasts showed that ImRs reduced emotional reactivity (*helpless*) to the memory more strongly from Session 1 to Session 2 than the control conditions, $t(75) = -3.05$, $p = .003$, $d = 0.73$, and ImRs led to stronger decreases in helplessness than PI, $t(75) = -2.12$, $p = .037$, $d = 0.59$. For anxiety, sadness, anger, and guilt, reductions of emotions to the memory could be observed from Session 1 to Session 2, all Fs$(1, 75) > 4.49$, ps $< .037$, η^2_ps $> .06$, with no differences between conditions, all Fs$(2, 75) < 2.29$, ps $> .109$, η^2_ps $< .06$. However, there was a (non-significant) descriptive trend indicating that ImRs reduced sadness (medium-sized interaction effect: $F(2, 75) = 2.03$, $p = .138$, $\eta^2_p = .05$) and anger (small- to medium-sized interaction effect: $F(2, 75) = 1.11$, $p = .336$, $\eta^2_p = .03$) more strongly than NIC and PI.

Reactivity of positive emotions (*happy, satisfied, proud)* was reduced from Session 1 to Session 2, all Fs$(1, 75) > 6.52$, ps $< .013$, η^2_ps $> .08$, with no differences between conditions, all Fs$(2, 75) < 1.39$, ps $> .256$, η^2_ps $< .04$.

Table 3.2. Means and standard deviations of emotional reactivity to the memory before (Session 1; t1-t0) and after the interventions (Session 2; t4-t3)

	Group	Session 1	Session 2
		M (*SD*)	*M* (*SD*)
Negative emotions			
Anxious	ImRs	22.69 (25.36)	9.23 (16.59)
	PI	20.24 (18.40)	9.97 (23.89)
	NIC	11.32 (20.53)	10.46 (22.34)
Angry	ImRs	32.89 (32.95)	18.25 (22.54)
	PI	26.86 (25.20)	19.98 (20.62)
	NIC	31.74 (40.16)	28.73 (31.95)
Sad	ImRs	41.27 (31.02)	23.80 (23.86)
	PI	32.69 (23.11)	26.84 (20.57)
	NIC	30.38 (23.12)	27.73 (24.45)
Guilty	ImRs	19.74 (29.49)	14.54 (19.57)
	PI	22.74 (31.99)	12.45 (23.87)
	NIC	19.85 (23.97)	14.81 (20.22)
Helpless	ImRs	42.11 (32.66)	21.52 (25.79)
	PI	33.55 (27.28)	30.44 (24.30)
	NIC	25.55 (29.00)	30.51 (29.74)
Positive emotions			
Happy	ImRs	-32.43 (18.24)	-18.74 (15.24)
	PI	-30.87 (14.86)	-20.46 (14.00)
	NIC	-27.68 (17.51)	-22.54 (13.37)
Satisfied	ImRs	-32.41 (18.77)	-20.97 (15.97)
	PI	-31.22 (21.28)	-22.10 (18.44)
	NIC	-28.57 (20.64)	-22.78 (15.63)
Proud	ImRs	-18.59 (24.16)	-9.03 (19.20)
	PI	-14.08 (27.12)	-12.31 (20.48)
	NIC	-23.10 (22.66)	-11.20 (16.05)
Arousal			
SAM	ImRs	2.81 (1.47)	1.69 (1.16)
	PI	2.84 (2.12)	2.20 (1.76)
	NIC	2.37 (1.60)	2.11 (1.40)

Note: ImRs = Imagery rescripting; PI = Positive imagery;
NIC = No-intervention control condition; SAM = Self-Assessment Manikin.

Self-reported arousal

For self-reported arousal (see Table 3.2), reductions in reactivity scores were observed from Session 1 to Session 2, $F(1, 75) = 11.19$, $p = .001$, $\eta^2_p = .13$, with no differences between conditions, all Fs$(2, 75) < 1.55$, ps $> .219$, η^2_ps $< .04$. Descriptively, there was a trend for

ImRs to yield stronger reductions of arousal compared to PI and NIC (medium-sized interaction effect: $F(2, 75) = 1.55$, $p = .219$, $\eta^2_p = .04$).

Memory distress

Changes in memory distress differed between groups as indicated by a significant Time x Condition interaction effect, $F(2, 74) = 3.36$, $p = .040$, $\eta^2_p = .08$. Planned contrasts showed that ImRs reduced memory distress more strongly from Session 1 to Session 2 compared to the control conditions (PI+NIC), $t(76) = -2.09$, $p = .040$, $d = 0.50$, and ImRs was superior to PI alone, $t(76) = 2.58$, $p = .012$, $d = 0.72$ (see Figure 3.2).

Stress symptoms

Results for the re-experiencing subscale of the RSDI (see Table 3.3) revealed that symptoms were reduced from Session 1 to Session 2, $F(1, 75) = 32.81$, $p < .001$, $\eta^2_p = .30$, with no differences between groups, all Fs$(2, 75) < 0.71$, ps $> .496$, η^2_ps $< .02$. Avoidance symptoms increased over time, $F(1, 75) = 3.98$, $p = .050$, $\eta^2_p = .05$, with no differences between conditions, Fs$(2, 75) < 0.35$, ps $> .703$, η^2_ps $< .01$. For the dissociation subscale no significant main or interaction effects were observed, all Fs$(1, 75 / 2, 75) < 2.35$, ps $> .129$, η^2_ps $< .03$.

Table 3.3. Means and standard deviations of stress symptoms during memory reactivation before (Session 1) and after the interventions (Session 2)

	Group	Session 1	Session 2
		M (*SD*)	*M* (*SD*)
RSDI			
Re-experiencing	ImRs	4.29 (3.44)	3.44 (1.26)
	PI	4.34 (3.81)	3.81 (1.01)
	NIC	4.57 (3.69)	3.69 (1.24)
Avoidance	ImRs	1.72 (1.37)	2.13 (1.42)
	PI	2.12 (1.34)	2.24 (1.41)
	NIC	1.79 (1.41)	2.12 (1.49)
Dissociation	ImRs	1.89 (1.18)	2.21 (1.42)
	PI	1.96 (1.05)	2.13 (1.16)
	NIC	1.71 (1.24)	1.80 (1.48)

Note: RSDI = Response to Script Driven Imagery Scale; ImRs = Imagery rescripting; PI = Positive imagery; NIC = No-intervention control condition.

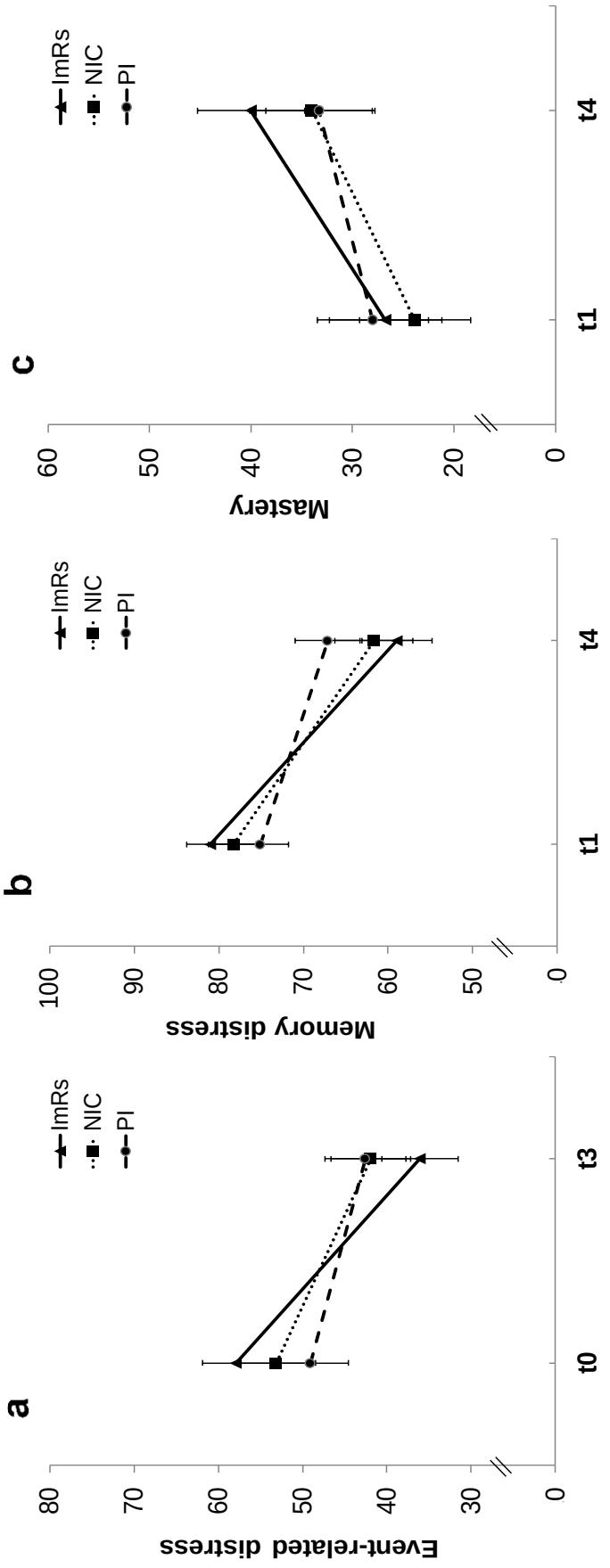

Figure 3.2. Effects of imagery rescripting (ImRs) vs. positive imagery (PI) vs. no-intervention control condition (NIC) on (a) distress related to the life-event during the last week, (b) memory distress, and (c) mastery; t0, t1: before the interventions (Session 1); t3, t4: after the interventions (Session 2); Error bars represent SEM.

Physiological outcomes

Heart rate

Reactivity of HR (Phase 1 and 2) in response to memory retrieval decreased from Session 1 to Session 2, all *F*s(1, 72/ 1, 70) > 9.13, $p < .003$, η^2_ps > .11, with no differences between groups, all *F*s(2, 72/ 2, 70) < 2.60, $p > .081$, η^2_ps < .07. For HR recovery, no significant main effects or interaction effects emerged, all *F*s(1, 72/ 2,72) < 1.50, $p > .225$, η^2_ps < .04. Descriptive data are provided in Table 3.4.

Skin conductance level

For SCL, reactivity (Phase 1 and 2) increased from Session 1 to Session 2, all *F*s(1, 72/ 1, 70) > 24.09, $p < .001$, η^2_ps > .26, but no differences between groups were evident, all *F*s(2, 72/ 2, 70) < 1.51, $p > .227$, η^2_ps < .04 (see Table 3.4). SCL recovery scores decreased over time, $F(1, 72) = 31.89$, $p < .001$, $\eta^2_p = .31$, with no differences between groups, all *F*s(2, 72) < 1.18, $p > .312$, η^2_ps < .03.

Electromyography

EMG reactivity to memory reactivation (Phase 2) decreased from Session 1 to Session 2, $F(1, 71) = 9.51$, $p = .003$, $\eta^2_p = .12$, but no significant differences between conditions emerged, all *F*s(2, 71) < 0.97, *p*s > .386, η^2_ps < .03. Results for EMG recovery revealed a significant Time x Condition interaction effect, $F(1, 71/ 2, 71) = 4.20$, $p = .019$, $\eta^2_p = .11$. Planned contrasts showed that ImRs did not significantly differ from the control conditions (PI+NIC), $t(69.99) = -0.65$, $p = .517$, $d = 0.15$, but there was a trend indicating that ImRs yielded stronger recovery in Session 2 compared to PI, $t(35.59) = 2.01$, $p = .0.52$, $d = 0.56$. Descriptive data are displayed in Table 3.4.

Table 3.4. Means and standard deviations of physiological reactivity and recovery scores before (Session 1) and after the interventions (Session 2)

	Group	Session 1	Session 2
		M (*SD*)	*M* (*SD*)
Reactivity (with talking)			
HR	ImRs	13.60 (8.54)	8.02 (6.49)
	PI	16.06 (12.29)	11.24 (7.82)
	NIC	15.64 (8.79)	11.51 (8.04)
SCL	ImRs	0.18 (0.38)	0.86 (0.85)
	PI	0.24 (0.64)	0.75 (0.95)
	NIC	0.13 (1.04)	0.78 (0.90)
EMG	ImRs	0.14 (3.23)	-1.25 (2.34)
	PI	-0.36 (2.34)	-1.46 (2.80)
	NIC	0.68 (2.74)	-1.27 (3.12)
Reactivity (without talking)			
HR	ImRs	0.38 (5.41)	-0.47 (4.11)
	PI	3.37 (5.37)	1.17 (4.32)
	NIC	3.64 (6.60)	1.28 (4.17)
SCL	ImRs	-.33 (0.59)	0.67 (0.88)
	PI	-.23 (0.69)	0.43 (0.81)
	NIC	-.60 (1.07)	0.66 (1.44)
EMG	ImRs	1.63 (2.20)	0.20 (3.04)
	PI	1.29 (3.34)	0.87 (3.60)
	NIC	2.31 (3.62)	0.73 (5.07)
Recovery			
HR	ImRs	0.07 (3.48)	0.41 (3.67)
	PI	2.07 (3.14)	0.51 (3.78)
	NIC	1.88 (3.54)	0.79 (4.87)
SCL	ImRs	-0.45 (0.60)	0.47 (0.78)
	PI	-0.40 (0.77)	0.17 (0.93)
	NIC	-0.70 (1.15)	0.47 (1.47)
EMG	ImRs	0.28 (2.14)	-1.02 (1.58)
	PI	0.03 (1.63)	-0.16 (1.57)
	NIC	0.54 (1.89)	-1.32 (1.87)

Note: ImRs = Imagery rescripting; PI = Positive imagery; NIC = No-intervention control condition; HR = Heartrate in bpm; SCL = skin conductance level in µS; EMG = Electromyography in µV. Reactivity = memory reactivation - baseline; Recovery = recovery phase – baseline.

Discussion

The present study examined whether ImRs leads to a revaluation of memory contents of distressing real-life events regarding perceived mastery and reduces subjective emotional and physiological responding to the distressing memories when compared to a positive imagery condition (PI) and no intervention (NIC). Thus, this study aimed to test a mechanism potentially underlying ImRs: Specifically, a change in the meaning of the memory, which is suggested to then lead to an attenuation of emotional and physiological responding when the memory is retrieved after treatment (see Arntz, 2012; Foa et al., 1989).

Effects on stress symptoms

In line with the hypothesis and in accordance with results from clinical studies (Morina et al., 2017), ImRs participants reported to experience the strongest reductions of event-related distress during the 1-week follow-up period. However, this treatment effect was not evident for stress symptoms evoked by the memory reactivation task (i.e., re-experiencing, avoidance, dissociation) as measured with the RSDI. For avoidance and dissociation symptoms floor effects were observed (baseline levels for avoidance: M = 1.87, SD = 1.37; dissociation: M = 1.85, SD = 1.15; scale ranging from 0 [*not at all*] to 6 [*a great deal*]) that probably impeded the detection of possible intervention effects in the current non-clinical sample. Re-experiencing symptoms were reported to be more pronounced (M = 4.40, SD = 0.92), but it appears that one brief ImRs session was not enough to yield treatment effects over and above habituation effects. Alternatively, it is possible that involuntary re-experiencing could not be assessed in a reliable way during the memory reactivation task, possibly due to the fact that participants were instructed to actively generate vivid mental images of the hotspot and to stay with these images. Re-experiencing symptoms might be more reliably measured using script-driven memory reactivation tasks (see Lang, Levin, Miller, & Kozak, 1983).

Changing the meaning of the memory: Effects on perceived mastery

Unexpectedly, the beneficial effects of ImRs treatment on perceived mastery could not be replicated (Kunze et al., 2019; Strohm et al., 2019). ImRs was not superior to the control

conditions and the intervention yielded lower increases in perceived mastery (d = 0.47) when compared to our earlier study (Strohm et al., 2019: d = 1.17). One possible explanation for the inconsistent findings might be that in the current study mastery was assessed immediately after participants had reached the hotspot. This means that memory contents were (explicitly) reactivated that had not been addressed during ImRs as the rescripting of the memory was initiated at the point in the sequence of events that *followed* the hotspot (see Dibbets & Arntz, 2016). In our earlier study, participants were asked for mastery ratings after they had completed their description of the entire (original) sequence of events. This may indicate that new meanings regarding mastery might be better accessible after treatment when the rescripted parts of the memory are reactivated (see Strohm et al., 2019). Memory contents that have not been changed through the intervention, however, might still be associated with the original negative meanings. This is of interest with respect to two differential memory processes that have been discussed to underlie the change in meaning through ImRs. While the results challenge the notion that ImRs directly changes the original memory representation of the aversive stimulus, for example via reconsolidation processes (see e.g., Arntz, 2012), they may be more in line with the idea that ImRs builds a new and more positive memory representation, which then competes with the original one for retrieval depending on respective retrieval cues (e.g., Brewin, 2006).

Moreover, it is conceivable that the adapted ImRs protocol as used in the present (and our earlier study) has to be optimized in order to yield stable effects on perceived mastery across studies. Looking at the experimental and clinical research literature, different variants of ImRs protocols have been used and it still remains an open question how ImRs is optimally delivered to successfully change memory-related meanings. Comparing "active" versus "passive" ImRs interventions, perceived mastery has been shown to be equally enhanced when individuals are encouraged to imagine themselves to intervene (i.e., "active") versus when they were asked to imagine helpers to change the situation (i.e., "passive"; Siegesleitner, Strohm, Wittekind, Ehring, & Kunze, 2019b). However, it is less clear how actively therapists should be involved during ImRs. In the current study, rescripting of the memory was performed by participants themselves with the experimenters only asking supportive questions but not making suggestions for possible changes to the image. This procedure might be problematic for individuals feeling too powerless to intervene in the image or struggling to generate alternative and more adaptive meanings that can be incorporated during ImRs. For these individuals clinical protocols (e.g. Arntz & Weertman,

1999) recommend therapists to take a more directive role by providing alternative meanings or introducing changes to the image themselves during ImRs. Furthermore, clinical protocols typically instruct patients to first enter the situation as their adult self and to then switch to the younger self's perspective (see Arntz & Weertman, 1999; Wild & Clark, 2011). This change of perspective was not explicitly included in the present ImRs protocol, but might have been helpful to increase perceived mastery, as it enables individuals to self-distance of what is happening in the image thereby making adaptive meanings probably more accessible. Another way to support patients to change dysfunctional meanings might be a cognitive preparation phase (as typically done with SAD patients; see Wild & Clark, 2011), in which participants are first encouraged to explicitly challenge memory-related dysfunctional beliefs and to generate more adaptive meanings (e.g., the self as being a valuable person/competent/strong/powerful) that are then incorporated into the memory using ImRs in a second step.

Subjective emotional responses to memory retrieval

Findings of the manipulation check showed that the memory reactivation task was successful in activating aversive memories. All distinct negative emotional states assessed (*anxious, angry, sad, guilty, helpless*) reached medium to high levels after memory reactivation (see Table B.1 in the Supplementary Material). As hypothesized and in line with findings from previous studies (Nilsson et al., 2012; Reimer & Moscovitch, 2015; Strohm et al., 2019), ImRs led to greater decreases in memory distress than the control conditions. Moreover, ImRs participants reported the strongest reductions of helplessness. For anxiety, sadness, anger, guilt and self-reported arousal no significant group differences emerged, but for sadness, anger and arousal there was a descriptive trend toward ImRs yielding stronger decreases than PI and NIC (small- to medium-sized interaction effects). Participants of all groups reported lower reactivity of positive emotions at follow-up.

Taken together, these findings partially support the notion that ImRs attenuates subjectively experienced emotional responding to aversive autobiographical memories. For feelings of helplessness, introducing meaning-relevant changes to the memory with ImRs (e.g., mental images of the self being in control/ being able to handle the aversive situation/ being a strong person) was more beneficial than generating unrelated positive images and meanings as done in PI (e.g., mental images of holidays, personal achievements). As ImRs

was not superior to the control conditions in enhancing perceived mastery (see previous section), the present findings challenge the notion that reductions in emotional responding through ImRs are specifically produced by changing negative meanings about mastery. In fact, ImRs may have modified different types of meanings. For example, although the situation itself may still be appraised as uncontrollable (i.e., appraisal of the situation stays unchanged), the self may nevertheless be perceived as being more competent to deal with the situation (i.e., appraisals about the self has changed), thus feeling less helpless. Alternatively, emotional changes through ImRs may precede cognitive changes. In other words, it is possible that reductions in negative emotions are not produced by reappraisal of memory-related meanings; in fact corrective emotional experiences during ImRs might lead to changes of negative meanings (see e.g., Lane, Ryan, Nadel, & Greenberg, 2015). As dysfunctional beliefs associated with traumatic memories exhibit large variability (e.g., depending on the nature of the life-event), future studies should integrate more comprehensive and/or more individualized measures of memory-related meanings about the self, others and the world (see e.g., Moscovitch, Gavric, Merrifield, Bielak, & Moscovitch, 2011).

Finally, it is important to note that the results on subjective responses to the memory were inconsistent across emotional states. Specifically, ImRs was not superior to control conditions in reducing anxiety and guilt (for sadness and anger, ImRs was superior only on a descriptive level). Looking at the life-events reported in the present sample, it is plausible that anxiety was not the principal memory-related emotion (see Table B.1 in the Supplementary Material), which may explain the lack of treatment effects on anxiety. Preliminary evidence suggests that ImRs is more effective in addressing non-fear emotions (e.g., guilt) when compared to imaginal exposure (Arntz, Tiesema, & Kindt, 2007; Grunert, Weis, Smucker, & Christianson, 2007). However, more systematic research is needed to address the question how ImRs compares to other interventions, such as imaginal exposure treatment (e.g., Rothbaum & Schwartz, 2002) or eye movement desensitisation and reprocessing (EMDR; e.g., Lee & Cuijpers, 2013), in reducing distinct memory-related emotional states.

Physiological responses to memory retrieval

The manipulation check revealed that physiological measures differed in their reactivity to the memory reactivation phases. While HR was reactive to both phases, EMG activity increased only in response to the imagination of the hotspot without talking (Phase 2) and

SCL only in response to the imagination with verbal narrative (Phase 1; see Figures B.1-3 in the Supplementary Material).

Contrary to the hypothesis, SCL reactivity increased over time with no differences between groups. This finding can most likely be explained by the fact that baseline SCL scores for Session 1 were found to be unexpectedly high (and significantly higher when compared to Session 2) resulting in only small SCL increases when confronted with the memory reactivation task Phase 1 and even SCL reductions when confronted with Phase 2 (see Figure B.2 in the Supplementary Material) before treatment. It is probable that within the current study design, too little time was allowed for SCL to reach resting baseline levels during Session 1 (see Dawson, Schell, & Filion, 2007). Furthermore, SCL might also have been increased due to anticipatory arousal to the expected experimental tasks. Consequently, findings for SCL are difficult to interpret with respect to the study hypotheses.

For physiological arousal (indexed by HR) and negative emotional valence (indexed by EMG corrugator activity) reductions in response to memory reactivation from Session 1 to Session 2 emerged in all groups, indicating that in the present study ImRs had no beneficial effects on physiological reactivity over and above habituation effects through exposure to the memory contents (during the memory reactivation task that was the same in all conditions). From a theoretical perspective, the observed reductions of physiological reactivity may indicate that emotional processing has taken place across groups (see Foa et al., 1989). This is surprising given that exposure to memory contents was very short in the control conditions (4-6 min). Moreover, ImRs participants, but not NIC and PI participants, were supported to actively integrate corrective information (meanings) into the memory, but this appeared to have no additional effect on physiological responding. However, it is important to note that non-traumatic aversive memories were examined in healthy individuals and physiological reactivity can be expected to be lower in the present sample when compared to patient populations with traumatic memories (e.g., PTSD, SAD). Therefore, replications in clinical samples are clearly needed to answer the question whether ImRs reduces physiological responding to aversive memories and how the intervention compares to exposure treatments in addressing physiological hyper-reactivity.

Interestingly, the present results revealed a trend indicating that ImRs yielded stronger physiological recovery as measured with EMG when compared to PI. As emotional dysregulation in PTSD has not only be linked to enhanced physiological reactivity, but also to a failure to physiologically recover after exposure to trauma-related stimuli (e.g., Norte et al.,

2012), future research should test the effects of ImRs on physiological recovery in clinical samples.

Limitations

The results of the current study have to be interpreted in light of the following limitations: First, as ImRs was not compared to other therapeutic interventions (e.g., prolonged exposure or cognitive restructuring) it remains unclear whether the reported intervention effects are specific for ImRs treatment. It is also possible that the observed effects can (partially) be explained by the greater extent of exposure to the memory in the ImRs condition. In order to draw conclusions about differential effects and working mechanisms (e.g., which intervention is most effective in addressing different negative meanings, subjective emotional responding or physiological reactivity?), future studies should integrate experimental conditions controlling for the extent of exposure to the memory and/or active treatment conditions. Second, in the present sample, it was not possible to test associations between hypothesized mechanisms (e.g., changes in emotional responding to the memory) and symptomatic change, for example via mediational analyses (Kazdin, 2007). Thus, only preliminary interpretations about mechanisms underlying ImRs treatment can be drawn. Moreover, perceived mastery, memory distress and emotional states were assessed each by only one item thereby limiting the reliability of results. As an analogue sample with individuals reporting non-traumatic life-events was used, findings cannot be generalized to patient populations with traumatic memories. Moreover, memories of recent life-events (within the past 24 months) were included. In clinical practice, however, ImRs is often employed for childhood memories, which might be less prone to change (Alberini, 2011) and which can be expected to be linked to more persistent dysfunctional beliefs about the self, others and the world (e.g., Young, Klosko, Weishaar, 2003). In the present study an additional phase of memory reactivation without talking was used in order to be able to interpret altered physiological responding as resulting from psychological processes and not as a function of changes in respiratory patterns produced during speech. However, the present procedure has the disadvantage of not measuring the initial physiological response to memory reactivation (i.e., Phase 1 in the present procedure) without participants talking out loud. Future studies should use script-driven imagery tasks, which allow a highly standardized presentation of the

aversive memory contents with physiological measurements not being contaminated by speech behavior.

Conclusion

Findings of the present study show that ImRs reduces subjectively experienced distress and feelings of helplessness associated with aversive autobiographical memories. The beneficial effects of ImRs on perceived mastery were not replicated in the present study indicating that the observed change in memory-related emotional responding were not produced by changes in beliefs about perceived mastery. The effects of one brief ImRs session on physiological reactivity did not exceed habituation effects through mere exposure to memory contents. To further examine mechanisms underlying ImRs, additional research in clinical populations is needed to clarify how the present findings translate to clinically relevant traumatic memories.

4. Study III:

Imagery Rescripting versus Cognitive Restructuring for Social Anxiety: Treatment Effects and Working Mechanisms

Abstract

Negative mental images in social anxiety are often linked to memories of distressing social experiences. Imagery rescripting (ImRs) has been found to be a promising intervention to target aversive memories, but mechanisms underlying ImRs are largely unknown. The present study aimed to replicate findings on the effects of ImRs compared to cognitive restructuring (CR) for social anxiety and to extend previous research by examining working mechanisms. Highly socially anxious individuals (*N*=77) were randomly allocated to ImRs, CR, or no intervention (NIC). A speech task was performed at baseline and at 1-week follow-up. Only CR led to substantial reductions in social anxiety symptoms at follow-up. Decreases in negative appraisals and emotional distress in response to the speech task did not differ between conditions. Regarding variables indicative of working mechanisms, ImRs led to stronger increases in positive emotions than CR and NIC. Both active treatments yielded immediate reductions in emotionally anchored idiosyncratic self-beliefs, but CR was superior to ImRs at follow-up. The present study supports the benefits of CR for social anxiety. Findings indicate that ImRs needs to be optimized when delivered as a brief stand-alone intervention in a subclinical analogue sample. The interpretation of results on potential working mechanisms is limited as ImRs was not effective in reducing social anxiety symptoms. Future directions for research into working mechanisms of ImRs are discussed.

Introduction

Negative mental imagery in social anxiety

Cognitive models of social anxiety disorder (SAD) suggest that negative mental images of the self are a key maintaining factor of the disorder (Clark & Wells, 1995; Hofmann, 2007; Rapee & Heimberg, 1997). Image content is often linked to former aversive social experiences (e.g., being bullied, being publicly criticized; Hackmann, Clark, & McManus, 2000). It is suggested that in socially anxious individuals memories of these experiences are stored in the form of negative self-images, which are reactivated later in anxiety-provoking situations (Hirsch, Meynen, & Clark, 2004).

Cognitive behavioral therapy (CBT) is considered to be the treatment of choice for SAD (Mayo-Wilson et al., 2014) and typically includes cognitive and behavioral techniques (Hofmann & Smits, 2008). Although CBT programs for SAD have been found to be efficacious, a substantial proportion of patients do not achieve clinically significant improvements by the end of treatment (Hofmann & Smits, 2008; Mayo-Wilson et al., 2014; Rodebaugh, Holaway, & Heimberg, 2004). Given the role of socially traumatic memories in SAD, it has been suggested that specifically targeting these aversive memories might be promising (Norton & Abbott, 2017; Wild & Clark, 2011).

Imagery rescripting as a treatment approach for social anxiety

Imagery rescripting (ImRs) is an imagery-based intervention for aversive memories that has increasingly been incorporated in CBT programs for SAD (e.g., Wild & Clark, 2011; McEvoy & Saulsman, 2014). During ImRs, patients are instructed to visualize an aversive memory and to change it in imagination according to their emotional needs (Arntz, 2012; Holmes, Arntz, & Smucker, 2007). Thus, ImRs aims to update the idiosyncratic meaning of the memories thereby reducing associated negative (self-)images, beliefs, and emotions (Arntz, 2012; Morina, Lancee, & Arntz, 2017). There is promising evidence that ImRs may be an efficacious treatment strategy for different disorders including SAD (for a meta-analysis, see Morina et al., 2017). Several studies have found that one session of ImRs significantly improved social anxiety symptoms (Lee & Kwon, 2013; Wild, Hackmann, & Clark, 2007; Wild, Hackmann, & Clark, 2008), also when delivered as a stand-alone intervention, i.e., without prior cognitive restructuring (CR; Nilsson, Lundh, & Viborg, 2012;

Norton & Abbott, 2016; Reimer & Moscovitch, 2015). Norton and Abbott (2016) specifically compared the effects of one session of ImRs versus CR. Results showed that both interventions equally reduced social anxiety symptoms and yielded reductions in anticipatory appraisal and distress with respect to an impromptu speech. However, CR was superior to ImRs in reducing maladaptive self-beliefs while only ImRs led to decreases in negative self-imagery indicating that the interventions may differ regarding their working mechanisms (Norton & Abbott, 2016).

Mechanisms underlying imagery rescripting

Research into mechanisms underlying ImRs is only in its beginnings, but in order to optimize the intervention, a better understanding of how ImRs works is crucial. It has been proposed that ImRs might work by changing the idiosyncratic meaning of aversive experiences (Arntz, 2012) and, more specifically, by leading to *emotionally anchored reappraisal* of core beliefs (Norton & Abbott, 2016; Nilsson et al., 2012; Wild et al., 2008). During ImRs, positive meanings are offered in the form of images. Based on evidence that mental imagery elicits stronger emotions than verbal thinking (Holmes & Mathews, 2010), it is conceivable that generating alternative meanings during ImRs is associated with stronger emotional activation than questioning maladaptive beliefs verbally (Holmes, Lang, & Shah, 2009). Consequently, it has been argued that alternative meanings offered in the form of images might be more emotionally anchored, more believable, and more likely to lead to changes in behavior than meanings that are exclusively generated as verbal representations (Holmes & Mathews, 2010). This assumption is in line with the idea that one can distinguish between different levels of meaning representations (see e.g., Barnard & Teasdale, 1991; but also Power & Dalgleish, 1999). According to the Model of Interacting Cognitive Subsystems (ICS; Barnard & Teasdale, 1991), intellectual beliefs (propositional level) can be distinguished from emotional beliefs (implicational level). Intellectual beliefs are described as knowing something "with the head", whereas emotional beliefs correspond to an intuitive and implicit sense of knowing "with the heart" or "having a gut feeling" (Barnard & Teasdale, 1991). Cognitive treatment strategies can be expected to change beliefs primarily on a propositional level. ImRs, however, as an experientially oriented treatment technique invokes different sensory modalities thereby addressing the implicational meaning level, which is suggested to be necessary to then change emotional beliefs (see Arntz, 2012; Wild et al.,

2008). Although *emotionally anchored reappraisal* (i.e., changing emotional beliefs) has often been discussed as a mechanism underlying ImRs (Norton & Abbott, 2016; Nilsson et al., 2012; Wild et al., 2008), empirical evidence is largely missing. Preliminary evidence stems from a study investigating the effects of ImRs on emotional versus intellectual beliefs in a sample of patients with Bulimia Nervosa (Cooper, Todd, & Turner, 2007). ImRs was found to be more effective than a control intervention in reducing emotional self-beliefs in this study. However, it needs to be tested whether these results generalize to socially anxious individuals. To conclude, it remains an open question whether ImRs elicits stronger emotions thereby being more effective than verbal interventions in changing emotional beliefs in social anxiety.

What works for whom?

In order to optimize psychological interventions, it is not only important to understand working mechanisms, but also to identify factors that can be used to tailor treatment to patients' characteristics (Norcross & Wampold, 2011), such as habitual use of certain modalities or strategies. First evidence suggests that habitual use of imagery is not associated with symptom changes in imagery-enhanced CBT for SAD (McEvoy, Erceg-Hurn, Saulsman, & Thibodeau, 2015), but this has not specifically been tested for stand-alone ImRs. The effects of CR, on the other hand, may be influenced by the individual's habitual use of cognitive reappraisal. It has been found that cognitive reappraisal increases during CBT for SAD (Goldin et al., 2012), but it is less clear whether individuals with higher use of reappraisal before treatment benefit more from CR.

The present study

The present study aimed to 1) investigate the effects of ImRs and CR as stand-alone interventions for social anxiety, 2) extend previous research by exploring mechanisms underlying ImRs, and 3) examine factors that might be used to select treatment strategies for the individual patient. Laboratory-based analogue studies in healthy or subclinical samples have been suggested to be a valuable means to investigate models of psychopathological processes and treatment mechanisms under highly controlled and standardized conditions (for reviews, see Scheveneels, Boddez, Vervliet, & Hermans, 2016; Van den Hout, Engelhard, &

McNally, 2017). The present study was based on the procedure of an earlier clinical study by Norton and Abbott (2016), but a sample of individuals with subclinical levels of social anxiety symptoms was used. Highly socially anxious individuals were randomly allocated to either one session of ImRs, one session of CR, or to a no-intervention control condition (NIC). Outcomes were assessed at baseline and at 1-week follow-up. A speech task was included to examine intervention effects on responses to a social stressor.

In line with previous findings, ImRs and CR were expected to yield greater decreases in social anxiety symptoms than NIC. It was hypothesized that ImRs and CR would reduce negative appraisals and emotional responses (i.e., subjective physiological arousal and distress) to the speech task when compared to NIC. Regarding the proposed mechanisms, ImRs was assumed to lead to stronger emotional activation than CR. While ImRs and CR were expected to be equally effective in decreasing strength of intellectual self-beliefs, it was hypothesized that ImRs would yield stronger reductions in strength of emotional self-beliefs. Additionally, the relationship between the hypothesized mechanisms and symptomatic change were explored. Finally, it was examined whether habitual use of imagery and cognitive reappraisal would influence outcomes of ImRs and CR.

Method

Participants

Highly socially anxious individuals were recruited via advertisements on university campus and social media. To partake in the study, participants had to score ≥30 (clinical cut-off) on the German version of the Social Interaction Anxiety Scale (SIAS; German version: Stangier, Heidenreich, Berardi, Golbs, & Hoyer, 1999) in an online screening.

During the first session, eligible participants were administered the Mini International Neuropsychiatric Interview for DSM-IV (M.I.N.I. 5.0.0; Sheehan et al., 1998; German version: Ackenheil, Stotz-Ingenlath, Dietz-Bauer, & Vossen, 1999) to screen for exclusion criteria: 1) current diagnosis of Major Depressive Disorder, 2) current and/or lifetime diagnosis of Posttraumatic Stress Disorder/ Psychotic Disorder/ Bipolar Disorder, 3) Substance Dependence during the past 12 months, 4) acute suicidal tendencies. Further exclusion criteria were: 5) age <18 or >35 years, 6) current psychological treatment, 7) pregnancy, 8) severe physical illness. Additionally, participants had to meet the following inclusion criteria (assessed with the Imagery Interview): 1) negative mental self-image(s) in feared social situations, 2) aversive social experience related to the image, and 3) maladaptive self-belief.

A total of 96 participants attended Session 1, 16 of which had to be excluded after baseline interviews (*n*=10 current/lifetime diagnosis of mental disorders specified above; *n*=4 no negative mental self-image; *n*=2 no maladaptive self-belief). Three participants did not attend the follow-up session, leaving a final sample of 77 highly socially anxious participants (80.52% female; age: M = 22.46, SD = 3.88). All participants gave written informed consent and were reimbursed by receiving partial course credit or 20€. The study was approved by the local Research Ethics Committee at LMU Munich.

Clinical interviews

The M.I.N.I. (Sheehan et al., 1998; German version: Ackenheil et al., 1999) was administered to assess current diagnoses according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association [APA], 2000). Additionally, the SAD module of the Structured Clinical Interview for DSM-IV Axis I

(SCID-I; First, Spitzer, Gibbon, & Williams, 1997; German version: Wittchen, Zaudig, & Fydrich, 1997) was administered.

Imagery interview

The Imagery Interview was based on the Waterloo Images and Memories Interview (WIMI; Moscovitch, Gavric, Merrifield, Bielak, & Moscovitch, 2011) and on the interview used by Norton and Abbott (2016). The semi-structured interview assessed negative self-imagery, aversive memories, and maladaptive self-beliefs. First, participants were provided a definition of mental imagery. Second, participants were asked to define their most anxiety-provoking social situation and to image themselves being in such a situation (with eyes closed). They were instructed to become aware of whether there was a mental image that tends to come to their mind in this kind of situation and to describe the mental image in detail. Third, participants were asked when they first felt the way they did in the image and to imagine the respective event describing the situation in the first person, present tense. This was used to determine whether there was an early aversive memory related to the mental image and gather information on this memory. Finally, participants opened their eyes. In order to specify the idiosyncratic self-belief derived from the negative mental image and the aversive memory, they were then asked: "What do the image and the memory tell about you as a person?". Participants were instructed to summarize the meaning of the image in form of a short statement.

Speech task

In order to measure reactions to a social stressor, participants were asked to give a 3min video-recorded impromptu speech (see Norton & Abbott, 2016) on a given political topic in both sessions (the order of the two topics was counterbalanced). Participants were informed beforehand that the speech would be evaluated later by independent raters and they were given 30sec to prepare the speech.

Symptom measures

Social interaction anxiety

The 20-item SIAS (Mattick & Clarke, 1998; German version: Stangier et al., 1999) was used to assess social interaction anxiety during the past seven days on a scale ranging from 0 (*not at all*) to 4 (*extremely*). The SIAS has been shown to be a specific and sensitive screening instrument for SAD and has demonstrated good psychometric properties (Mattick & Clarke, 1998; Stangier et al., 1999; internal consistencies in the present study: Cronbach's α's=.88-.91).

Fear of negative evaluation

The 12-item Brief Fear of Negative Evaluation Scale-Revised (BFNE-R; Carleton, McCreary, Norton, & Asmundson, 2006; German version: Reichenberger et al., 2016) was administered to measure fear of negative evaluation by others on a scale ranging from 1 (*not at all characteristic of me*) to 4 (*extremely characteristic of me*). The German version of the BFNE-R has demonstrated good psychometric properties (Reichenberger et al., 2016; internal consistency in the present study: Cronbach's α's=.93-.94).

Depressive symptoms

In order to test for baseline group differences in depressive symptoms, the Patient Health Questionnaire-9 Item (PHQ-9; Krönke, Spitzer, & Williams, 2001; German version: Löwe, Spitzer, Zipfel, & Herzog, 2002) was administered. The PHQ-9 is a reliable and valid measure of depression severity (Krönke et al., 2001)

Speech task measures

Public speaking anxiety

In order to verify the relevance of the speech task as a stressor participants were asked to indicate how anxious they had felt when giving a speech/presentation during the last week (or how much they imagined they would have felt if no situation had occurred), on a scale from 0 (*not at all anxious*) to 3 (*extremely anxious*).

Appraisals of negative evaluation of the speech

The Probability and Consequences Questionnaire (PCQ; Rapee & Abbott, 2007) asks participants to rate their appraisal of the likelihood (7 items) and cost (7 items) of negative evaluation of their speech on a scale ranging from 0 (*not at all likely/bad*) to 4 (*extremely likely/bad*). In the current study, subscales showed good internal consistencies (probability-subscale: Cronbach's α's=.79-.83; cost-subscale: Cronbach's α's=.87-.88).

Distress

Subjectively experienced levels of distress were assessed using Subjective Units of Distress (SUD), ranging from 0 (*not at all distressed*) to 100 (*extremely distressed*).

Arousal

Self-assessment manikins (SAM; Bradley & Lang, 1994) were used to assess self-reported physiological arousal on a scale ranging from 1 (*very calm*) to 9 (*very aroused*).

Measures of mechanisms

Emotional activation

The Positive and Negative Affect Schedule -Extended (PANAS-X; Watson & Clark, 1994; German version: Grühn, Kotter-Grühn, & Röcke, 2010) was administered to assess changes in positive and negative emotions. In this study the general dimensions "positive affect" (PA) and "negative affect" (NA) were included as well as the subscales "fear", "hostility", "guilt", "sadness", "joviality", "self-assurance", and "attentiveness". Scales range from 1 (*very slightly or not at all*) to 5 (*extremely*). Internal consistencies were good in the current study (PA: Cronbach's α's=.82-.89; NA: Cronbach's α's=.80-.85).

Strength of intellectual and emotional beliefs

The idiosyncratic maladaptive self-belief was identified during the Imagery Interview. The self-belief was read out to participants, and they were asked to rate the strength of this belief in two ways (see Cooper et al., 2007). For the intellectual belief, participants were asked to indicate how much they would rationally agree to their belief on a scale ranging from 0 *(I do not agree at all*) to 100 (*I completely agree).* For the emotional belief, participants

were asked how much they *felt* the belief was true, regardless of what they were thinking rationally on a scale ranging from 0 *(feels not true at all*) to 100 (*feels completely true).*

Habitual use of mental imagery and cognitive reappraisal

The Spontaneous Use of Imagery Scale (SUIS; Kosslyn, Chabris, Shephard & Thompson, 1998; German version: Görgen, Hiller, & Witthöft, 2016) was administered to assess inter-individual differences in everyday use of mental images. Scales range from 1 (*never appropriate*) to 5 (*completely appropriate*). The German version has demonstrated good reliability (Cronbach's α=.85; Görgen et al., 2016; present study: Cronbach's α=.81).

The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003; German version: Abler & Kessler, 2009) measures the frequency of habitual use of cognitive reappraisal with six items that are rated on a scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The German version has demonstrated good reliability (Abler & Kessler, 2009; present study: Cronbach's α=.78).

Interventions

Imagery rescripting

The ImRs procedure was based on protocols by Arntz and Weertman (1999) and Wild and Clark (2011). Participants were first given a short rationale. Stage 1 of the intervention started with participants closing their eyes and vividly imagining the aversive memory (identified in the Imagery Interview) from the perspective of their younger-self. Participants were instructed to describe the situation in the first person, present tense, and to include all sensory modalities. This first stage aimed to reactivate emotions related to the memory. Stage 2 of ImRs was initiated by instructing participants to imagine the scene from the perspective of their current adult-self who is witnessing the events as a bystander. Participants were asked to describe what they see is happening to their younger-self and were then encouraged to intervene in any way they wished. When the adult-self felt fully satisfied, Stage 3 was initiated by asking participants to relive the memory again from the perspective of their younger-self, experiencing the interventions of their adult-self (as induced during Stage 2). Additionally, the younger-self was encouraged to express further unmet needs (e.g., emotional support, compassion, distraction). When the needs of the younger-self were

satisfied and participants did not wish to apply further changes, the ImRs procedure was concluded by asking participants to dwell on the final positive image (see Nilsson et al., 2012; Norton & Abbott, 2016). Note that the ImRs procedure was not preceded by cognitive restructuring, nor did the instructions explicitly refer to the idiosyncratic self-belief. The mean duration of ImRs was 22.35min (*SD* = 6.20).

Cognitive restructuring

The cognitive restructuring procedure was based on the protocol by Wild and Clark (2011). After participants had been provided a rationale, they were asked to outline evidence for their idiosyncratic negative self-belief. Participants were then encouraged to challenge the self-belief by collecting evidence against it. To support this process participants were asked to consider alternative explanations for their experiences (including the early aversive memory), to think of experiences contradicting the maladaptive belief, and to evaluate the aversive memory from an adult perspective. All evidence for and against the negative self-belief was written down on a worksheet. Finally, participants were instructed to rephrase the original maladaptive belief into a more helpful statement. The mean duration of CR was 23.74min (*SD* = 4.40).

No-intervention control condition

Participants in the no-intervention control group were provided neutral magazines and were instructed to wait for 30min in the laboratory. They were asked not to use personal belongings.

Procedure

The study comprised two sessions, which were one week apart. Two experimenters carried out different parts of the procedure so that the speech task and intervention were not administered by the same experimenter. For a detailed overview, see Figure 4.1.

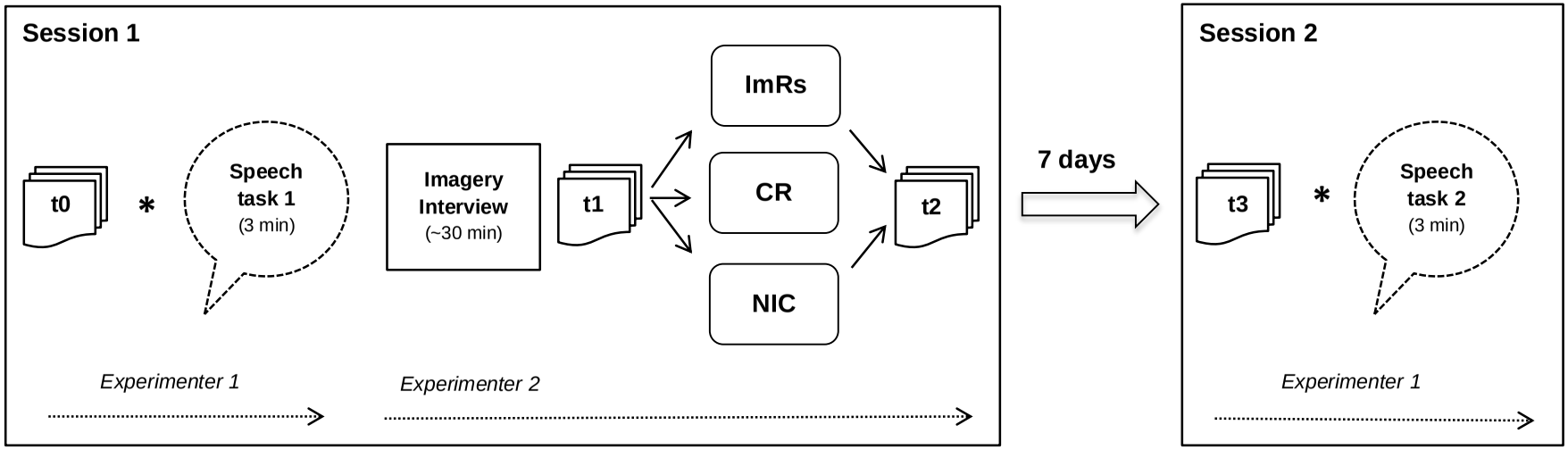

Figure 4.1. Schematic overview of the study procedure.
ImRs = Imagery rescripting; CR = Cognitive restructuring; NIC = No-intervention control condition.
Session 1: Experimenter 1 administered the clinical interviews (M.I.N.I., SAD module of the SCID-I) and baseline measurements (t0: sociodemographic data, SIAS, BFNE-R, public speaking anxiety, SUIS, ERQ), followed by the speech task and the associated measures (* = SUD, SAM, PCQ). Experimenter 2 then conducted the Imagery Interview and administered the pre-treatment questionnaires (t1: intellectual and emotional belief, PANAS-X). After that, participants were randomly allocated to ImRs (n = 25), CR (n = 27), or NIC (n = 25). The allocation sequence was computer-generated and Experimenter 2 was blind to condition until the beginning of the interventions, while Experimenter 1 was blinded during the entire study procedure. Immediately after the interventions or the waiting period, participants completed post-treatment measures (t2: intellectual and emotional belief, PANAS-X).
Session 2: One week later participants returned and Experimenter 1 administered the follow-up questionnaire (t3: SIAS, BFNE-R, intellectual and emotional belief) and the second speech task including speech task measures (* = SUD, SAM, PCQ). Finally, participants were fully debriefed.

Statistical analyses

A series of 2(Time) x 3(Condition) repeated measures ANOVAs were carried out for social anxiety symptoms (t0; t3), for speech task measures (pre-speech1; pre-speech2), and for positive and negative emotions (t1; t2). To follow up significant interaction effects, planned contrasts on change scores were conducted (ImRs+CR vs. NIC; ImRs vs. CR). Effects on intellectual and emotional self-beliefs were tested with 3(Time) x 3(Condition) repeated measures ANOVAs. Significant interaction effects were followed up using planned contrasts (ImRs+CR vs. NIC; ImRs vs. CR). For ImRs participants, Pearson correlations were computed between mechanisms and symptomatic change, and between habitual use of mental imagery and symptomatic change. For CR, correlations were computed between habitual use of cognitive reappraisal and symptomatic change. A significance level of α=.05 (two-tailed) was used for all analyses. Partial eta squared (η^2_p) or Cohen's *d* were used as effect sizes.

Power analysis

Results of a sample-size calculation (two-tailed, α = .05, power = .80, run with G*Power 3.1) with medium to large effect sizes (*d* = .70; see Morina, 2017) showed that a sample size of 76 was required to detect significant differences between active treatments and NIC.

Results

Participant characteristics and baseline comparisons

There were no significant baseline differences between conditions in any of the variables (see Table 4.1). Mean age at the time of the aversive event was 12.86 years (*SD* = 4.55; range 3-27), with significant differences between groups[4] (ImRs: *M* = 13.88, *SD* = 4.90; CR: *M* = 13.76, *SD* = 4.60; NIC: *M* = 10.88, *SD* = 3.55), $F(2,74) = 3.78$, $p = .027$.

Social anxiety symptoms

Social interaction anxiety

For SIAS scores (see Table 4.2), there was no main effect of Condition, $F(2, 74) = 1.97$, $p = .147$, $\eta^2_p = .05$, but a significant effect of Time, $F(1, 74) = 17.94$, $p < .001$, $\eta^2_p = .20$, and a significant interaction effect, $F(2, 74) = 3.22$, $p = .046$, $\eta^2_p = .08$. Planned contrasts revealed that there was no difference between active treatment groups compared to NIC in reducing social interaction anxiety, $t(74) = 1.05$, $p = .298$, $d = 0.26$. However, CR led to stronger decreases than ImRs, $t(74) = 2.29$, $p = .025$, $d = 0.64$. Descriptively, substantial reductions in SIAS scores were only evident in CR ($M_{diff} = 6.22$, *SD* = 7.87), but not in ImRs ($M_{diff} = 1.76$, *SD* = 6.46) or in NIC ($M_{diff} = 2.20$, *SD* = 6.59), see Figure 4.2.

Fear of negative evaluation

Results for BFNE-R (see Table 4.2 for descriptive statistics) revealed a significant main effect of Time, $F(1, 74) = 5.70$, $p = .020$, $\eta^2_p = .07$, but neither a significant effect of Condition, $F(2, 74) = 1.09$, $p = .342$, $\eta^2_p = .03$, nor a significant interaction effect, $F(2, 74) = 2.90$, $p = .061$, $\eta^2_p = .07$. Descriptively, there was a trend indicating that CR ($M_{diff} = 3.61$, *SD* = 4.22) led to stronger reductions in fear of negative evaluation than both ImRs ($M_{diff} = 0.76$, *SD* = 7.03) and NIC ($M_{diff} = 0.16$, *SD* = 5.10), see Figure 4.2.

[4] It was tested whether age of the aversive memory (i.e. time that had passed since the event) had an influence on main symptomatic outcomes. However, results remained unchanged when including age of the memory as a covariate. Note that age of the aversive memory was not significantly different in the two active treatment conditions (ImRs and CR).

Table 4.1. Demographic variables and pre-treatment characteristics

	Overall Sample (n = 77)	ImRs (n = 25)	CR (n = 27)	NIC (n = 25)	Statistics
Demographics					
Gender (n female/male)	62/15	21/4	20/7	21/4	$\chi^2(2) = 1.10$, $p = .577$
Age in years, *M (SD)*	22.36 (3.88)	22.64 (3.81)	22.59 (3.91)	21.84 (4.01)	$F(2,74) = 0.33$, $p = .718$
Social anxiety symptoms, *M (SD)*					
SIAS	40.29 (12.55)	40.84 (13.21)	37.93 (12.06)	42.28 (12.49)	$F(2,74) = 0.81$, $p = .447$
BFNE-R	40.48 (10.39)	40.20 (11.00)	39.44 (10.36)	41.88 (10.07)	$F(2,74) = 0.36$, $p = .696$
SAD Criteria (DSM-IV) met, n (%)	21 (27.27)	8 (32)	8 (29.63)	5 (20)	$\chi^2(2) = 1.02$, $p = .599$
Comorbidity (n yes/no)	7/70	3/22	3/24	1/24	
Generalized Anxiety Disorder, n	2	0	1	1	
Dysthymia, n	3	1	2	0	
Anorexia Nervosa, n	1	1	0	0	
Bulimia Nervosa, n	1	1	0	0	
Public Speaking Anxiety, *M (SD)*	1.94 (0.85)	1.92 (0.95)	1.93 (0.96)	1.96 (0.61)	$F(2,74) = 0.02$, $p = .984$
Habitual use of imagery, *M (SD)*					
SUIS	53.84 (11.16)	55.28 (10.42)	54.40 (12.09)	52.00 (11.08)	$F(2,74) = 0.60$, $p = .551$
Habitual use of reappraisal, *M (SD)*					
ERQ	25.78 (6.50)	25.72 (7.32)	26.00 (5.88)	25.63 (6.49)	$F(2,74) = 0.02$, $p = .978$

Note: ImRs = Imagery rescripting; CR = Cognitive restructuring; NIC = No-Intervention Control Condition; SIAS = Social Interaction Anxiety Scale; BFNE-R = Brief Fear of Negative Evaluation Scale-Revised; SAD = Social Anxiety Disorder; DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, 4th edn; SUIS = Spontaneous Use of Imagery Scale; ERQ = Emotion Regulation Questionnaire.

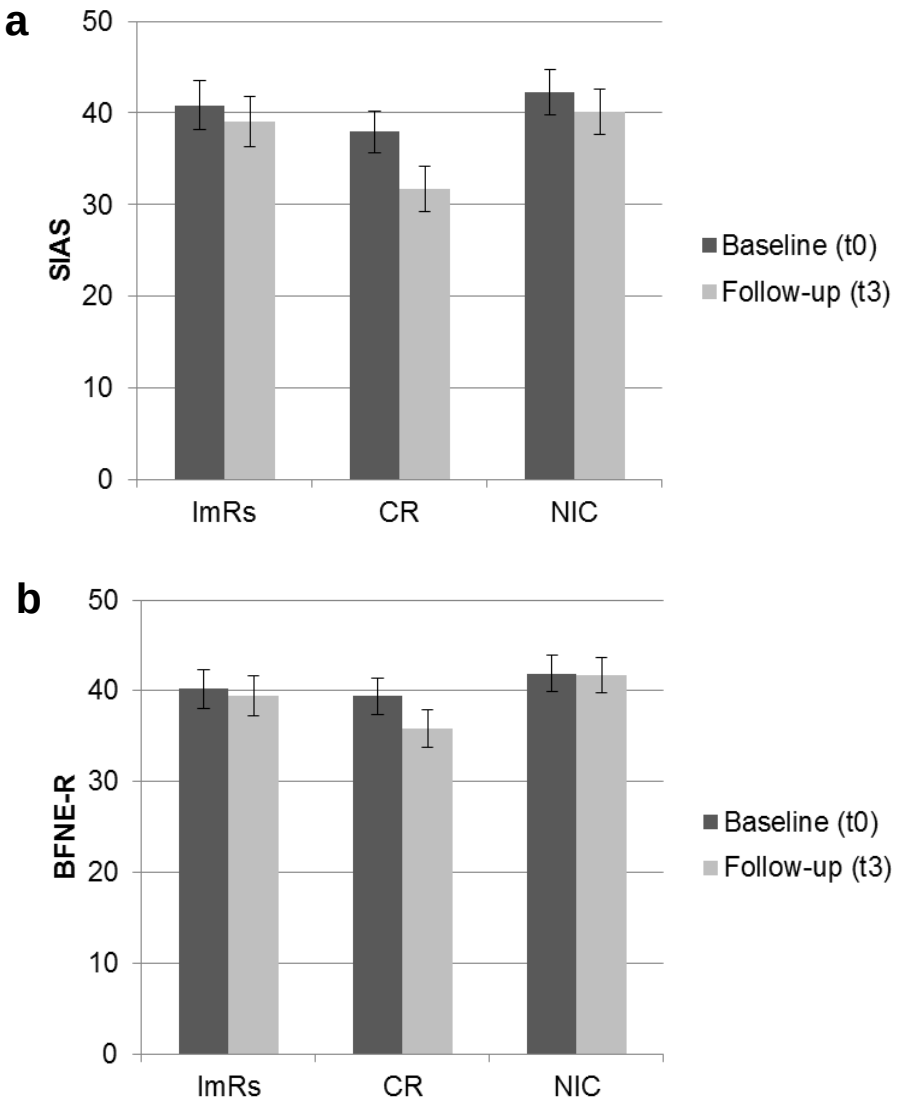

Figure 4.2. Effects of imagery rescripting (ImRs) vs. cognitive restructuring (CR) vs. no-intervention control condition (NIC) on (a) social interaction anxiety (SIAS), and (b) fear of negative evaluation (BFNE-R). Error bars represent SEM.

Table 4.2. Means and standard deviations for symptom measures and mechanism variables before the interventions (t0/t1), after the interventions (t2) and at follow-up (t3)

	Group	t0 / t1	t2	t3
		M (*SD*)	*M* (*SD*)	*M* (*SD*)
SIAS				
	ImRs	40.84 (13.21)		39.08 (13.84)
	CR	37.93 (12.06)		31.70 (12.91)
	NIC	42.28 (12.49)		40.08 (12.45)
BFNE-R				
	ImRs	40.20 (11.00)		39.44 (11.03)
	CR	39.44 (10.36)		35.84 (10.98)
	NIC	41.88 (10.07)		41.72 (9.72)
PANAS PA				
	ImRs	23.12 (5.20)	30.48 (8.21)	
	CR	22.89 (6.79)	26.41 (7.12)	
	NIC	22.92 (6.13)	23.44 (6.89)	
PANAS NA				
	ImRs	19.04 (6.77)	13.92 (3.64)	
	CR	18.19 (6.29)	14.41 (5.37)	
	NIC	18.60 (5.58)	13.48 (3.12)	
Intellectual belief				
	ImRs	51.60 (27.53)	39.40 (26.91)	48.80 (26.55)
	CR	64.74 (29.83)	40.37 (25.79)	42.52 (29.49)
	NIC	57.8 (33.32)	55.48 (32.32)	57.24 (29.63)
Emotional belief				
	ImRs	90.40 (10.88)	62.52 (19.71)	73.80 (18.10)
	CR	84.07 (16.82)	56.11 (29.00)	52.78 (27.92)
	NIC	83.08 (20.92)	81.36 (21.90)	79.60 (20.74)

Note: ImRs = Imagery rescripting; CR = Cognitive restructuring; NIC = No-intervention control condition; SIAS = Social Interaction Anxiety Scale; BFNE-R = Brief Fear of Negative Evaluation Scale-Revised; PANAS = Positive and Negative Affect Schedule; PA = positive affect; NA = negative affect.

Speech task measures[5]

Appraisals of negative evaluation of the speech

For both subscales of the PCQ, there were significant main effects of Time, all Fs(1, 74) > 9.74, ps < .003, η^2_ps > .12, but no significant interaction effects, all Fs(2, 71) < 2.28, ps > .110, η^2_ps <.06.

[5] In some participants, speech-related questionnaires were erroneously not administered (PCQ: n = 3; SUD: n = 4; SAM: n = 2) and these participants were excluded from the respective analyses.

The main effect of Condition was significant for probability, $F(2, 71) = 3.13$, $p = .050$, $\eta^2_p = .08$, but not for cost of negative evaluation, $F(2, 71) = 1.13$, $p = .330$, $\eta^2_p = .03$. ImRs and CR did not yield significantly greater reductions in appraisals of negative evaluation compared to NIC (see Table 4.3).

Table 4.3. Means and standard deviations for speech task measures before (speech 1) and after (speech 2) intervention

	Group	Speech 1	Speech 2
		M (*SD*)	*M* (*SD*)
Negative Evaluation: Probability[a]			
	ImRs	15.46 (4.25)	14.79 (4.66)
	CR	13.04 (5.62)	10.27 (5.45)
	NIC	14.25 (5.93)	13.33 (5.93)
Negative Evaluation: Cost[a]			
	ImRs	13.50 (5.87)	12.25 (6.10)
	CR	12.46 (6.71)	9.27 (4.64)
	NIC	13.79 (5.98)	12.29 (6.52)
Distress (SUD)[b]			
	ImRs	66.50 (29.77)	57.42 (27.33)
	CR	75.12 (22.01)	55.35 (28.42)
	NIC	72.17 (23.10)	65.65 (24.33)
Arousal (SAM)[c]			
	ImRs	6.67 (1.61)	5.79 (1.35)
	CR	6.62 (1.50)	5.65 (1.67)
	NIC	6.28 (1.67)	6.00 (1.61)

Note: ImRs = Imagery rescripting; CR = Cognitive restructuring; NIC = No-intervention control condition; SUD = Subjective Units of Distress; SAM = Self-Assessment Manikins.
[a]$n = 74$; [b]$n = 73$; [c]$n = 75$.

Distress

For SUD, a significant effect of Time was found, $F(1, 70) = 17.41$, $p < .001$, $\eta^2_p = .20$, but neither a significant main effect of Condition nor a significant interaction effect could be observed, Fs$(2, 70) < 2.12$, ps $> .128$, η^2_ps $< .06$. Reductions in distress in response to the speech did not differ between conditions (see Table 4.3).

Arousal

Results for SAM revealed a significant effect of Time, $F(1, 72) = 11.35$, $p = .001$, $\eta^2_p = .14$, but neither a significant effect of Condition nor a significant interaction effect emerged,

$F(2, 72) = 1.05$, $p = .354$, $\eta^2_p = .03$. ImRs and CR were not more effective than NIC in reducing arousal in response to the speech (see Table 4.3).

Mechanisms

Activation of positive and negative emotions

For PANAS PA and NA (see Figure 4.3) there were significant effects of Time, all Fs(1, 74) > 35.10, ps < .001, η^2_ps > .32, but no significant effects of Condition, all Fs(2, 74) < 2.17, ps > .121, η^2_ps < .05. While no significant interaction effect was found for PANAS NA, $F(2, 74) = 0.57$, $p = .570$, $\eta^2_p = .02$, a significant interaction emerged for PANAS PA, $F(2, 74) = 9.29$, $p < .001$, $\eta^2_p = .20$. Planned contrasts revealed that active treatments increased positive emotions more strongly compared to NIC (M_{diff} = -0.52, SD = 4.48), $t(60.89) = 3.97$, $p < .001$, $d = 0.97$, with ImRs (M_{diff} = -7.36, SD = 6.81) leading to stronger increases than CR (M_{diff} = -3.52, SD = 5.35), $t(45.54) = 2.25$, $p = .029$, $d = 0.62$. For negative emotions, reductions emerged in all groups with no differences between conditions. Descriptive data are outlined in Table 4.2. Results for the remaining subscales of PANAS-X are provided in Table C.1 in the Supplementary Material.

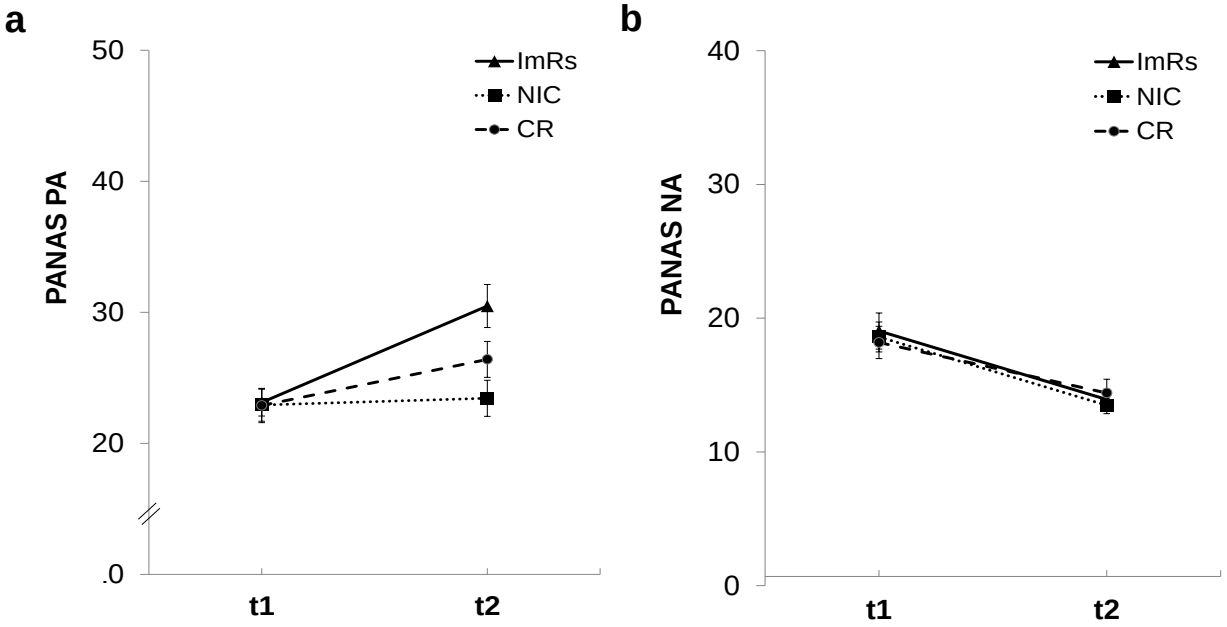

Figure 4.3. Effects of imagery rescripting (ImRs) vs. cognitive restructuring (CR) vs. no-intervention control condition (NIC) on (a) positive emotions (PANAS PA), and (b) negative emotions (PANAS NA); t1: before the intervention; t2: after the intervention; Error bars represent SEM.

Intellectual and emotional beliefs

Results per condition are illustrated in Figure 4.4. For intellectual beliefs, there was no significant effect of Condition, $F(2, 74) = 1.00$, $p = .373$, $\eta^2_p = .03$, but a significant effect of Time and a significant interaction effect, all Fs (3.63, 134.19 / 1.81, 134.19) > 6.12, ps < .001, η^2_ps > .14. Planned contrasts revealed that compared to NIC the active treatments led to stronger reductions in intellectual beliefs from pre- to post-intervention, $t(55.43) = 4.58$, $p < .001$, $d = 1.12$, and from pre to follow-up, $t(74) = 2.13$, $p = .036$, $d = 0.52$. While CR and ImRs equally reduced intellectual beliefs from pre- to post-intervention, $t(35.93) = 2.03$, $p = .050$, $d = 0.49$, CR led to stronger decreases than ImRs from pre to follow-up, $t(74) = 3.04$, $p = .003$, $d = 0.84$.

For emotional beliefs, there were significant effects of Time and Condition, all Fs (2, 74/ 2, 148) > 5.37, ps < .006, η^2_ps > .13, and a significant interaction effect, $F(4, 148) = 13.94$, $p < .001$, $\eta^2_p = .27$. Planned contrasts revealed that the active treatments reduced emotional beliefs more strongly than NIC from pre- to post-intervention, $t(60.66) = 8.51$, $p < .001$, $d = 2.07$, and from pre to follow-up, $t(69.14) = 5.62$, $p < .001$, $d = 1.37$. CR and ImRs were equally effective in decreasing emotional beliefs from pre- to post-intervention, $t(49.78) = 0.16$, $p = .878$, $d = 0.04$, but CR led to stronger reductions than ImRs from pre to follow-up, $t(48.13) = 2.67$, $p = .010$, $d = 0.74$.

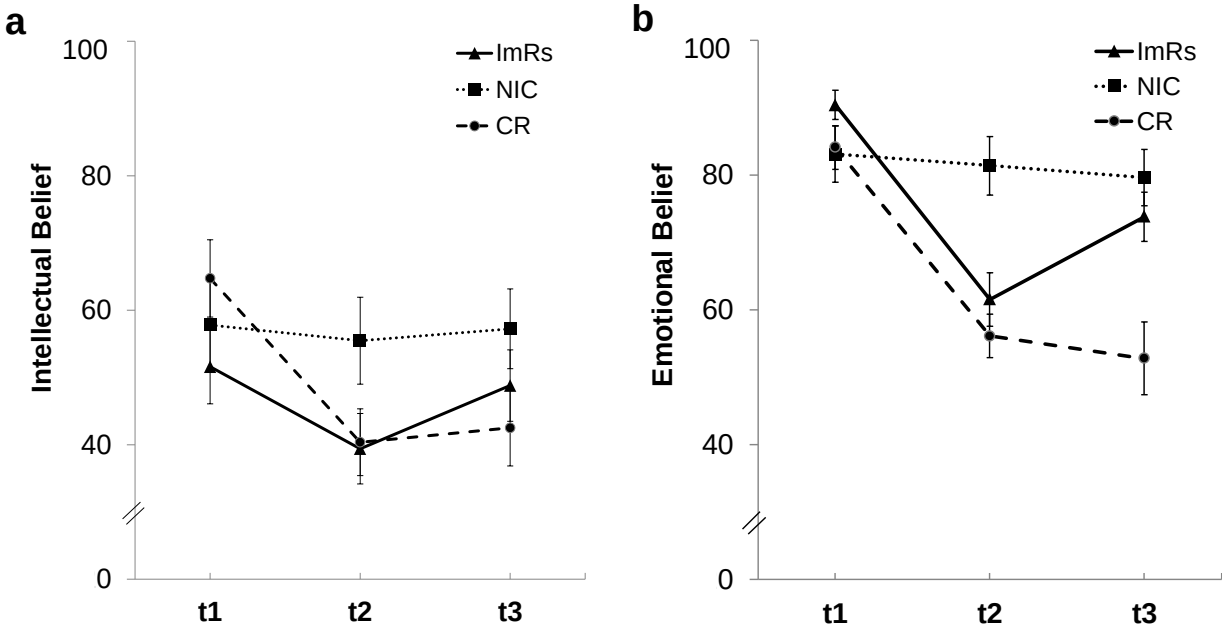

Figure 4.4. Effects of imagery rescripting (ImRs) vs. cognitive restructuring (CR) vs. no-intervention control condition (NIC) on (a) intellectual beliefs, and (b) emotional beliefs; t1: before the intervention; t2: after the intervention; t3: one-week follow-up; Error bars represent SEM.

Correlation between mechanisms and symptomatic change

Within the ImRs group, symptomatic change was not significantly correlated with changes in emotions (PA x SIAS: r = -.08; PA x BFNE-R: r = .26; NA x SIAS: r = -.35; NA x BFNE-R: r = .11; all ps > .085). Also, there was no significant correlation between pre-post changes in emotional beliefs and symptomatic change (SIAS: r = -.39; BFNE-R: r = .15; all ps > .055).

Habitual use of mental imagery and cognitive reappraisal strategies

In ImRs, SUIS scores were neither significantly correlated with changes on SIAS, r = .02, p = .931, nor with changes on BFNE-R, r = .02, p = .919. For CR, there was a trend towards significant positive correlations between ERQ scores and changes on SIAS, r = .34, p = .081, and BFNE-R, r = .37, p = .057.

Discussion

The present study examined the effects of ImRs versus CR for socially anxious individuals when compared to no intervention. The aim of the study was to 1) replicate the beneficial effects of stand-alone ImRs and CR on social anxiety symptoms within a subclinical sample, 2) extend previous research by investigating mechanisms underlying ImRs (i.e., activation of emotions and emotionally anchored reappraisal of idiosyncratic beliefs), and 3) explore factors that might be used to select treatment strategies for the individual patient.

Effects on social anxiety symptoms

Contrary to expectations, CR was superior to ImRs and NIC in reducing social interaction anxiety, with only CR yielding substantial improvements. No significant differences between groups were evident for fear of negative evaluation, but looking at the descriptive data there was a trend indicating that only CR led to substantial reductions (medium sized interaction effect). Previous findings regarding the effects of the interventions on responses to a social stressor could not be replicated (Norton & Abbott, 2016). When confronted with the speech task, participants in all conditions demonstrated equal reductions in distress, arousal, and negative appraisals suggesting that the active treatments had no benefits over and above mere exposure to the speech.

Taken together, findings support previous evidence for the beneficial effects of one session of CR to reduce social anxiety symptoms (e.g., Norton & Abbott, 2016; Shikatani, Antony, Kuo, & Cassin, 2014). However, in the present subclinical sample promising earlier findings on the benefits of stand-alone ImRs for social anxiety could not be replicated (Nilsson et al., 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015). Results for CR underline its efficacy within CBT for SAD, even when administered as a relatively short intervention (mean duration was 24min). Effect sizes for the superiority of CR compared to no treatment (and ImRs) were medium sized, but note that social anxiety symptoms remained above the clinical cut-off indicating that more sessions are necessary to achieve clinically significant improvements with CR (see also Norton & Abbott, 2016). Results for ImRs are surprising given that the present procedure was based on previous research (Nilsson et al., 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015). In line with these earlier studies

one session of ImRs was delivered without cognitive preparation in a non-clinical setting with a 1-week follow-up.

One possible explanation for the inconsistent findings might be that ImRs is more effective in individuals with more severe symptomatology. In the present study, a sample of highly socially anxious individuals was included (based on SIAS scores in the clinical range) whereas earlier studies investigated patients meeting diagnostic criteria for SAD (Nilsson et al., 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015). For SAD patients, correlations between anxiety symptomatology and socially traumatic experiences have been found and there is evidence that these experiences play a role in the development of the disorder (Norton & Abbott, 2017; Simon et al., 2009). In individuals with subclinical symptoms negative self-images and -beliefs might potentially be not as strongly linked to salient traumatic experiences. Therefore, it might be more helpful to target aversive memories with ImRs in SAD patients, while subclinical samples appear to benefit more from CR, possibly as this intervention challenges self-beliefs more directly. However, it should be noted that mean baseline symptom levels (i.e., SIAS scores) of the present study were comparable or even higher than those reported in previous studies for patient samples (Nilsson et al., 2012; Norton & Abbott, 2016), which makes differences in symptom severity a less likely explanation of the failure to replicate earlier treatment effects.

An alternative explanation might be that the ImRs intervention, which was used in the present study, needs to be optimized to produce changes in social anxiety symptoms. First, it is possible that treatment intensity needs to be enhanced (mean duration of ImRs was 22 min in the present study). Moreover, a highly standardized ImRs protocol was used in the current study, whereas other studies administered the intervention in a more individualized way (e.g., Norton & Abbott, 2016). In the present study, all participants were instructed to introduce changes themselves (i.e., therapists were not actively involved in the rescripting of the memory), which may have reduced the efficacy of the intervention. As suggested in the ImRs protocol by Arntz and Weertman (1999) for traumatic childhood memories, it might be necessary to modify the standard ImRs procedure when individuals struggle to access the perspective of the healthy adult-self and feel too powerless to confront others in the image. In these cases, therapists are proposed to take a more active role by either making suggestions for possible interventions or entering the image to intervene themselves. In the ImRs protocol for SAD (Wild & Clark, 2011), this therapist-led variant has not explicitly been proposed, but observations from the present study indicate that it might be helpful in some cases, as the

accessibility of a healthy adult perspective varied between participants. Future research should explicitly compare the efficacy of different ImRs protocols (for SAD) such as therapist- versus patient-led approaches or patients imagining helpers versus the adult-self to intervene (see Siegesleitner, Strohm, Wittekind, Ehring, & Kunze, 2019b).

Finally, in accordance with suggestions by Wild and Clark (2011), it might be necessary to administer ImRs in combination with CR (as done in Lee & Kwon, 2013; Wild et al., 2008). The present results indicate that CR alone might be superior to ImRs alone and question the notion that ImRs yields stable effects across different samples when delivered without cognitive preparation. However, whether a combination of ImRs and CR could outperform CR alone should further be investigated in future studies. An advantage of combining CR and ImRs might be that in a first step cognitive preparation may support patients to make the healthy adult perspective more accessible and to generate adaptive beliefs. Next, these updated beliefs about the self and others could be incorporated during ImRs, thereby updating mental imagery and possibly anchoring alternative meanings emotionally.

Mechanisms underlying imagery rescripting

In line with the hypothesis on activation of emotions, ImRs led to stronger increases of positive emotions than CR and NIC. For negative emotions, however, significant reductions emerged with no differences between conditions. ImRs and CR both reduced intellectual and emotional beliefs from pre- to post-intervention when compared to NIC, but CR was more effective in the long-term. In ImRs, neither changes in positive emotions nor in emotional beliefs correlated with symptomatic outcomes.

Findings for idiosyncratic self-beliefs (intellectual and emotional) and activation of positive emotions indicate that ImRs initiated the hypothesized beneficial (short-term) processes. Previous evidence for the more powerful impact of imagery interventions on positive emotions when compared with verbal processing, i.e. CR was replicated in the present study (Holmes & Mathews, 2010). The results further suggest that ImRs leads to emotionally anchored reappraisal of idiosyncratic beliefs in the short-term. However, as the intervention did not yield improvements on symptomatic outcome variables in the present study, it remains to be tested whether the aforementioned mechanisms play a role in producing symptomatic change.

Moreover, the present results challenge the notion that emotionally anchored reappraisal is a mechanism that is specific for ImRs. In fact, CR was also effective in targeting maladaptive emotional beliefs, disconfirming the theoretical idea that cognitive treatment strategies primarily change intellectual meaning levels (i.e., propositional level). Although CR reduced emotional beliefs in the present study, mean levels were still high at follow-up. From clinical experience, after having challenged beliefs verbally, a substantial number of patients report a discrepancy between rationally knowing (that their negative beliefs are not true) and feeling it deep inside. More systematic research is needed to test whether emotional beliefs can be further reduced with multiple sessions of CR, or whether ImRs might be more helpful or should be added when CR yields no substantial improvements.

What works for whom?

Participants who tended to habitually use mental imagery in daily life did not benefit from ImRs to a greater extent. This replicates previous evidence that the efficacy of ImRs does not depend on whether patients are used to operate in an imagery mode (McEvoy et al., 2015). However, these results have to be interpreted with caution, as no overall treatment effect of ImRs was observed. For CR, there was a trend indicating that those individuals benefited more who habitually used cognitive reappraisal as an emotion regulation strategy before treatment. This finding provides first evidence for a factor that might be used to make individualized treatment decisions.

Limitations

Results of the present study have to be interpreted in light of some limitations. ImRs and CR were delivered as brief interventions within a non-therapeutic setting. Thus, the interventions deviate from treatment as used in clinical practice (e.g., regarding therapeutic alliance, treatment intensity) limiting generalizability to clinical settings. As a subclinical sample was investigated, results cannot be generalized to patient populations. Emotional beliefs were rated on a one-item VAS, which might reduce reliability. Moreover, it is unclear whether changes in meaning representations on the implicational level can be measured via verbal ratings.

Conclusion

The present study compared the effects of ImRs versus CR as stand-alone interventions for socially anxious individuals and was the first to systematically examine mechanisms underlying ImRs for social anxiety. Results underline the efficacy of a brief CR intervention to reduce social anxiety symptoms. The failure to replicate the benefits of ImRs in the present study points towards difficulties of administering ImRs as a brief stand-alone intervention within laboratory settings in sub-clinical samples. The present findings provide first evidence that ImRs indeed activates stronger positive emotions than CR, but results challenge the notion that emotionally anchored reappraisal is a working mechanism specific for ImRs. However, results on potential working mechanisms have to be interpreted with caution given that ImRs was not effective in reducing social anxiety symptoms. The present study raises the question how ImRs interventions for socially anxious individuals should optimally be implemented in laboratory-based research. A cognitive preparation phase, more individualized ImRs protocols, and/or higher treatment intensity might be necessary to yield therapeutic effects.

5. General Discussion

The present thesis aimed to examine mechanisms underlying imagery rescripting (ImRs) for aversive memories. Using an adapted analogue paradigm for the investigation of ImRs in aversive autobiographical memories, *Study I* and *II* tested whether ImRs enhances perceived mastery of distressing experiences ("memory revaluation") and leads to a reduction of memory-related emotional and physiological responding. *Study III* compared the effects of ImRs versus cognitive restructuring (CR) in a subclinical sample of highly socially anxious individuals and addressed the question whether ImRs works through reappraisal of emotionally anchored dysfunctional beliefs. In the following, the main findings of the present thesis are summarized and future directions for research into working mechanisms of ImRs are discussed.

Summary of results

Psychological and physiological effects of imagery rescripting (Studies I and II)

Study I and *II* of this thesis presented an analogue research approach which overcomes limitations of the trauma film paradigm (TFP; for reviews, see Holmes & Bourne, 2008; James et al., 2016) by using ImRs for aversive autobiographical memories of real-life events. In this way, the present studies aimed to provide an ecologically more valid model of the memories that are targeted with ImRs interventions in clinical practice. In both studies, the adapted analogue paradigm was used to test a mechanism that had been hypothesized to underlie ImRs: According to a proposition by Arntz (2012), ImRs might work by changing the dysfunctional meaning of the memory representation of the aversive event ("memory revaluation") thereby reducing problematic emotional and physiological responses to the memory. The present studies specifically investigated whether ImRs leads to a revaluation of memory contents with respect to perceived mastery. Results only partially supported the hypothesized working mechanism. In *Study I* ImRs increased feelings of mastery of aversive life-events when compared to a no-intervention control condition (NIC) indicating that ImRs had led to a revaluation of the autobiographical memory contents. However, this treatment effect could unexpectedly not be replicated in *Study II*. With respect to emotional responding to memory retrieval, findings from both studies showed that subjectively reported memory distress and negative emotions can be reduced with ImRs. Importantly, changing meaning-relevant contents of the original memory with ImRs was superior to a positive emotion regulation strategy (PI), which induced mental images and meanings related to positive life-

events (*Study II*). However, it must be noted that different patterns of results were derived regarding the distinct emotional states, which had been successfully decreased with ImRs (*Study I*: sadness; *Study II*: helplessness). Regarding physiological reactivity to the memories (*Study II*), one brief ImRs session was not sufficient to yield reductions over and above mere exposure to the memory contents (NIC) or a positive emotion regulation strategy (PI).

Taken together, *Studies I* and *II* of the present thesis extended previous laboratory research on ImRs in artificially induced aversive memories (e.g., Dibbets & Arntz 2016; Dibbets et al., 2018; Hagenaars & Arntz 2012; Kunze, Arntz, & Kindt, 2019) by demonstrating that ImRs changes the (subjective) emotional valence of autobiographical memory representations of real-life events. The question how reductions in negative emotional responding to the memory relate to changes in dysfunctional meanings about mastery could not be answered conclusively given the inconsistent results for perceived mastery. An investigation of ImRs for autobiographical memories within the presented paradigm appears to be promising, although modifications are necessary given that the clinical efficacy of ImRs could not be modelled reliably across both studies. In *Study I* beneficial effects of ImRs on intrusive memory frequency emerged, however, the interpretation of results was limited as intrusive memories were assessed differently at baseline and post-intervention. An investigation of treatment effects on other psychopathological symptoms (e.g., event-related stress symptoms as assessed with the Impact of Event Scale-Revised and Response to Script Driven Imagery Scale) was impeded by floor effects. In order to address this limitation, *Study III* examined effects and mechanisms of ImRs in a subclinical sample of highly socially anxious individuals reporting symptoms of social anxiety above the clinical cut-off score at baseline.

Imagery rescripting for social anxiety: the role of emotionally anchored reappraisal (Study III)

Clinical research in the context of ImRs treatment has largely focused on patient samples reporting (early) aversive memories which are strongly linked to dysfunctional beliefs or schemas (e.g., Arntz, 2011; Arntz & Weertman, 1999; Wild & Clark, 2011). Therefore, *Study III* of the present thesis investigated the effects and working mechanisms of ImRs in a sample of highly socially anxious individuals reporting memories of early stressful social experiences, which were associated with dysfunctional beliefs about the self and/or

others. In the context of social anxiety disorder (SAD), it has been suggested that ImRs as an imagery-based intervention specifically works by reducing dysfunctional *emotional* beliefs (i.e. beliefs on the implicational meaning level, "felt beliefs"; see Nilsson et al., 2012; Norton & Abbott, 2016; Wild et al., 2008). However, findings from *Study III* did not support this hypothesis. Although results showed that ImRs indeed led to a reappraisal of dysfunctional emotional beliefs at post-intervention, CR was equally effective in reducing emotional beliefs and was even superior to ImRs in the longer-term (1-week follow-up). This result was surprising given that activation of positive emotions through ImRs was – as expected – stronger compared to CR. With respect to the proposed working mechanism, the present results therefore challenged the notion that emotionally anchored reappraisal might be a mechanism specific for ImRs. In fact, verbal interventions like CR appear to also target emotional beliefs. However, as one brief session of ImRs was investigated and as outcomes were assessed after a relatively short follow-up period, more research into the long-term effects of more intense ImRs versus CR treatment is needed. Moreover, it is important to note that the clinical efficacy of ImRs to reduce social anxiety symptoms (Nilsson et al., 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015) could not be replicated in the subclinical sample. The failure to model the benefits of ImRs on symptomatic outcomes in the laboratory setting limited the interpretation of results on potential working mechanisms and indicated that it appears to be necessary to optimize the ImRs protocol used in this study.

Implications for future research

This thesis presented different laboratory-based research approaches to investigate working mechanisms of ImRs in non-clinical samples. Findings from the current studies add to our knowledge on processes that might underlie the therapeutic efficacy of ImRs, although only preliminary conclusions can be drawn about potential working mechanisms. Findings on the effects of ImRs on symptomatic outcomes were rather mixed in the present analogue samples raising the question how the clinical efficacy of ImRs can be best modelled within laboratory-based research. The following chapter outlines potentials and limitations of the laboratory-based approach in the context of ImRs. Moreover, future directions for research into working mechanisms and into the optimization of ImRs interventions are discussed.

Investigating ImRs in laboratory-based analogue studies

The present analogue studies allowed to examine treatment mechanisms of ImRs in a highly controlled and standardized setting thereby minimizing the influence of confounding variables. However, several limitations of the introduced paradigms emerged, which need to be taken into account by future laboratory-based research in this field.

One major limitation of the present studies was that symptomatic change could not be consistently achieved in non-clinical samples. However, for a better understanding of mechanisms underlying psychological interventions it is crucial to examine the link between the hypothesized mechanisms and symptomatic change, for example, via mediational analyses (Kazdin, 2007). Due to floor effects on clinical symptom questionnaires an investigation of treatment effects of psychological interventions can be constrained in healthy samples (see *Study I* and *II*). Future research is therefore recommended to select individuals who exceed a priori defined cut-offs of symptom severity (as done in *Study III*). Alternatively, it might be worthwhile to specifically focus on certain psychopathological phenomena, such as intrusive memories, which (in milder forms) have been shown to be very common in healthy populations after highly emotional experiences (Marks et al., 2018). In a similar vein, findings from the present thesis have raised the question how ImRs needs to be optimally delivered in laboratory-based studies to provide an effective and ecologically valid model of clinical ImRs. The following issues might be worthwhile to consider in future analogue studies: First, ImRs is usually delivered over several sessions in patients and with a longer duration (mean duration of ImRs in the present studies: 14 - 22 min). Second, non-clinical samples may differ significantly from clinical, treatment-seeking populations regarding their lower treatment motivation and willingness to change, which may adversely affect therapeutic outcome of analogue ImRs. As ImRs is a highly emotion-evoking intervention this might additionally foster avoidance motivation of participants in non-clinical settings. Finally, laboratory-based interventions are usually administered without building up a therapeutic relationship, which may also be critical for therapeutic success within analogue settings (Bordin, 1994). Future studies need to test whether enhanced treatment intensity, more specific inclusion criteria (e.g., treatment motivation), allowing time for participants to become familiar with the experimental setting and/or integrating some of the key elements of the therapeutic alliance (e.g., by administering ImRs in Session 2 to give participants more time to develop a collaborative relationship of confidence; see Bordin, 1994) might solve these issues in future studies.

Although modelling the effects of ImRs on psychopathological symptoms in non-clinical samples appears to be challenging, analogue studies still have the potential to inform clinical research about treatment processes that might be involved in ImRs. Findings from the present thesis indicated that laboratory-based studies could be a suitable means to further examine effects of ImRs on different aspects of aversive autobiographical memories (e.g., which memory-related emotions can be reduced with ImRs? How can different emotions, such as guilt or shame, be optimally addressed with ImRs? Does ImRs change other types of meanings than perceived mastery? Does ImRs reduce the vividness of the memory? Does ImRs change factual details of the episodic memory?). Additionally, analogue studies might be promising to compare the effects of different variants of ImRs on the emotional valence of the memory (e.g., how much emotional activation is needed? Is it beneficial to rescript the memory in a way, that the aversive experience is prevented from happening? Is it helpful to take revenge within imagery? How important is it to switch perspective from the past/younger self to the current/ adult self during ImRs?). Moreover, laboratory-based research might be a valuable means to compare treatment mechanisms of ImRs and well-established interventions for aversive memories such as exposure-based therapies or Eye Movement and Desensitization Reprocessing (e.g., is ImRs superior in reducing non-fear emotions?).

Finally, it is important to note that in order to answer the question whether ImRs is an effective treatment to reduce symptoms in patients with different emotional disorders, it is undoubtedly necessary to additionally carry out studies in clinical samples (see also van den Hout et al., 2017). Nevertheless, laboratory-based studies in subclinical samples might be used for a preliminary investigation of ImRs effects for specific psychopathological problems or diagnostic categories, which have not been targeted with ImRs in the current literature (e.g., for a preliminary evaluation of adapted ImRs protocols that can then be tested in clinical case series; for a similar approach, see Tolgou et al., 2018).

Future directions for research into working mechanisms of ImRs

In addition to the aforementioned methodological implications, the present thesis points towards a number of open questions which are worthwhile to examine in future research for a better understanding of working mechanisms of ImRs. Findings of this thesis principally supported previous evidence that ImRs may work by changing dysfunctional meanings of aversive memories (e.g. Arntz, 2012; Kunze, 2018; Reimer & Moscovitch, 2015). However, it

needs to be further investigated, which types of meanings may be addressed with the intervention, how ImRs is optimally delivered to change memory-related meanings and how ImRs works on the level of memory processes.

Changing dysfunctional meanings of autobiographical memories with ImRs

Study I supported the notion that providing positive meanings regarding perceived *mastery* might play a role in ImRs interventions (see Germain et al., 2004; Kunze et al. 2016; Kunze et al., 2019; Long & Quevillon, 2009). In this regard, future studies should test whether a revaluation of memory contents of concrete (past) autobiographical life-events have generalized effects on fundamental beliefs about mastery (or self-efficacy) in future demanding or anxiety-provoking situations. Changing these more generalized dysfunctional beliefs about mastery might be crucial to reduce avoidance behavior and memory-related symptoms with the intervention. In a similar vein, it might be important to examine whether enhanced mastery during deliberate memory retrieval is associated with increased mastery of intrusive memory contents (Long & Quevillon 2009). Moreover, findings from this thesis indicate that it is relevant to further investigate how ImRs needs to be delivered in order to successfully enhance mastery. In *Study II* the positive effects of ImRs on mastery were not replicated and this might potentially be explained by the fact that participants rescripted their life-events in a way that rather included helpers changing the situation than themselves being actively intervening in the image. In a recent study, we are therefore specifically testing whether therapists should stimulate patients to imagine themselves intervening or whether it suffice to use helpers to change the situation in order to exert effects on perceived mastery (Siegesleitner et al., 2019b). In a similar vein, it has not been examined to which extent therapists should be involved in developing the new script during ImRs. To enhance perceived mastery it might be optimal for patients to rescript the sequence of events themselves, as this might be associated with the strongest increases in controllability and self-efficacy. On the other hand, observations from *Study III* indicated that (socially anxious) individuals sometimes struggled to carry out positive changes from the adult's perspective when the adult self did not feel strong enough to confront others in the image. In order to increase mastery in these individuals, it might be necessary that – in a first step – therapists develop the new script by entering the image and introducing more positive outcomes. The latter approach has also been suggested for patients with posttraumatic stress disorder (PTSD) who feel too powerless to intervene in the image (Arntz & Weertman, 1999). Additional

research is clearly needed to compare these patient- versus therapist-led ImRs approaches regarding their effects on mastery and symptomatic change.

While providing corrective information about mastery during ImRs might be one possibility to change the negative meaning of aversive autobiographical memories, it is conceivable that ImRs works by addressing different types of meanings as well. In patients with SAD, ImRs primarily aims to reduce negatively distorted mental images of the social self by generating more positive outcomes of originally aversive social experiences (see *Study III*), such as mental images of supportive others. In this way, ImRs has indeed been found to change memory-related dysfunctional meanings (or beliefs) about the self (e.g., "I am worthless") and others (e.g., "Other people will be judgmental and reject me") in patients with SAD (Nilsson et al., 2012; Reimer & Moscovitch, 2015). In patients with PTSD, memory-associated meanings typically include appraisals about serious current threat, which can be either external (e.g., "The world is a dangerous place") or internal (e.g., a threat to one's self concept as an acceptable or capable person; see Ehlers & Clark, 2000). In addition to offering corrective information about mastery (or controllability), ImRs might address these negative meanings by providing mental images of the individual being safe and/or the traumatized self being reassured (e.g., Arntz, 2012; Hackmann, 2011). Finally, depending on the respective life-event and the diagnostic status negative memory-related meanings may extremely differ between individuals. Future research into working mechanism of ImRs is therefore recommended to assess memory-related meanings more comprehensively using disorder specific questionnaires on dysfunctional cognitions or an assessment of memory-related idiosyncratic meanings (e.g., Moscovitch et al., 2011).

Improving ImRs treatment

Findings from *Study III* raised the question how ImRs is optimally delivered to change memory-related meanings given that the intervention did not yield sustainable change in dysfunctional beliefs (neither on the emotional nor on the intellectual level). In this regard, systematic comparisons of the effects of stand-alone ImRs versus a combination of CR and ImRs might be informative. Although imagery-based interventions have been suggested to have potential benefits over verbal interventions in addressing dysfunctional meanings, findings from *Study III* and from a previous study by Norton and Abbott (2016) demonstrated that one session of CR was superior to stand-alone ImRs in reducing negative self-beliefs. In contrast, there is also evidence that dysfunctional beliefs can be successfully reduced with

stand-alone ImRs (i.e., without deliberate cognitive restructuring; Nilsson et al., 2012; Reimer & Moscovitch, 2015). Future studies should clarify the need to explicitly reappraise memory-related meanings as part of ImRs interventions. Adding a preparation phase of cognitive restructuring before administering ImRs (as suggested in the protocol for SAD by Wild & Clark, 2011) might augment the therapeutic efficacy because dysfunctional beliefs are first challenged in a very explicit way (during CR) and newly developed adaptive meanings can then be incorporated in the memory during ImRs.

Alternatively, it is possible that ImRs does not work by (deliberate) cognitive revaluation of meanings, but rather by providing *corrective emotional experiences.* According to a recent account by Lane, Ryan, Nadel, and Greenberg (2015), therapeutic change occurs by activating autobiographical memories and the associated emotions and by incorporating *corrective emotional elements* into the memory structure. Based on evidence that event-memories and semantic memory structures are interactive (Ryan, Hoscheidt, & Nadel, 2008), it has been suggested that the updating of aversive memories through new experiences will lead to the development of new semantic structures (i.e., rules, beliefs; Lane et al., 2015). If the aforementioned working mechanism applied to ImRs, treatment efficacy might be augmented by supporting patients to emotionally engage in the intervention and to focus on the corrective emotional experience during the rescripting of the memory (rather than explicitly reappraising beliefs during ImRs). In this regard, it might also be relevant to further explore to which extent the original memory needs to be emotionally activated and how much exposure to the aversive memory contents is needed before the rescripting phase is initiated. On the one hand, it has been proposed that activated emotional arousal and the expectation of the upcoming trauma may suffice (e.g., Arntz, 2015; Arntz & Weertman, 1999). On the other hand, preliminary results indicate that ImRs might be more effective when the rescripting of the memory is initiated after the most aversive scenes of the memory has been relived (including the hotspot) before the memory is changed (Dibbets & Arntz, 2016). Relatedly, it appears to be important to explore the impact of (imaginal) exposure to the aversive memory contents as an active treatment component of ImRs interventions. Dismantling studies may contribute to a better understanding of the active treatment ingredients of ImRs and their impact on symptomatic outcomes (see also Kunze, 2018).

Memory processes underlying ImRs

This thesis showed that ImRs changes the emotional quality of aversive memories and reduces memory-related dysfunctional meanings. However, it remains an open question *how* exactly ImRs works on the level of memory processes. Two distinct mechanisms have been suggested in this regard. On the one hand, ImRs might *directly* modify the original memory representation by activating the memory and updating it during memory reconsolidation (Arntz, 2012; Kunze, 2018). On the other hand, ImRs might generate an alternative, positively valenced memory trace which then competes with the original aversive memory representation for retrieval (see retrieval competition theory, Brewin, 2006). The experimental procedures of *Studies I* and *II* were designed to initiate memory reconsolidation processes (see James et al., 2015), but they did not allow to explicitly test whether ImRs indeed updated the memories during reconsolidation. If ImRs indeed was a means to interfere with memory reconsolidation processes and to directly change the averseness of the original memory representation, this could promote the generalization of treatment effects to different contexts outside the treatment setting. In this way, ImRs might reduce relapse rates compared to contingency-based exposure interventions, which keep the valence of the original event memory unchanged and therefore typically have to be repeated in many different contexts (Arntz, 2012; Kunze et al., 2019).

Although evidence for successful memory updating during reconsolidation is still limited for psychological interventions, the investigation of memory updating via reconsolidation appears to be an important avenue of research in clinical psychology given the pathogenic role of aversive memories in a number of emotional disorders (Beckers & Kindt, 2017). As memory updating via reconsolidation depends on a number of parameters, future research should also clarify under which conditions ImRs may initiate memory reconsolidation processes and under which conditions it rather facilitates the formation of an alternative memory trace (see also Kunze, 2018). In this regard, the duration of exposure to the original memory appears to be crucial, indicating that the extent of memory reactivation needs to be optimized before the rescripting is initiated (e.g., Suzuki et al., 2004). Moreover, there is evidence that a prediction error (i.e., a discrepancy between the actual and the expected outcome) is needed to destabilize a memory (Exton-McGuinness, Lee, & Reichelt, 2015). Thus, it appears to be crucial that expectancies are violated during memory retrieval for memory reconsolidation to occur. During ImRs expectancies might be violated when the feared outcome of the aversive event does not occur in imagery. However, it needs to be

tested whether this involves preventing the hotspot from happening during ImRs or whether the rescripting of the sequence of events may be also initiated after the hotspot has been reactivated (see also Kunze, 2018). More research is clearly needed to clarify whether and how ImRs might update memories via reconsolidation processes.

What works for whom?

In order to enhance the efficacy of psychological treatments, it is not only important to understand processes of change, but also to identify factors that need to be taken into account to tailor interventions to patients' characteristics (Norcross & Wampold, 2011). Findings from *Study III* indicated that participants who tended to habitually use mental imagery in daily life did not benefit from ImRs to a greater extent (see also McEvoy et al., 2015). However, the literature is still inconclusive regarding the question whether an individual's *ability* to generate mental images influences treatment outcomes (Hunt & Fenton, 2007; Lee & Kwon, 2013; McEvoy et al., 2015). Moreover, it is conceivable that the patient's openness for emotion evoking experiential interventions may impact the therapeutic efficacy of ImRs. Finally, the present thesis was based on recent accounts considering ImRs as a rather homogenous therapeutic intervention, which may be applied transdiagnostically with largely uniform treatment mechanisms across disorders (see e.g., Arntz, 2012; Morina et al., 2017). However, until now it is an open empirical question whether different treatment protocols introduced under the term *imagery rescripting* indeed are variants of the same clinical intervention or whether ImRs may be (re-)defined as a collection of imagery-based interventions with differential working mechanisms for different forms of psychopathology. Future research into ImRs should therefore aim to answer the question which variant of ImRs works best to modify which kind of psychopathological processes in which groups of patients.

Conclusion

To augment the efficacy of psychological treatments it is crucial to understand how therapeutic change occurs. This thesis introduced different laboratory-based research approaches to investigate working mechanisms of ImRs for aversive autobiographical memories. The present findings extended previous experimental research by showing that ImRs changes the emotional quality of autobiographical memories as well as memory-related

dysfunctional meanings. The question whether an increase of perceived mastery constitutes a working mechanism of ImRs needs to be further investigated. Additional research is also needed to clarify how findings from the present laboratory studies translate to ImRs for traumatic memories in clinical populations. Although no final conclusions about the working mechanisms of ImRs can be drawn yet, the present thesis adds to our knowledge of potentials and limitations of laboratory-based research for the investigation of processes involved in ImRs. A better understanding of mechanisms underlying therapeutic change will be an important step towards optimized and more effective ImRs interventions for the treatment of emotional disorders associated with aversive autobiographical memories.

Zusammenfassung

Imagery Rescripting als Behandlungsmethode für aversive autobiographische Erinnerungen: Effekte und Wirkmechanismen

Imagery rescripting (ImRs) ist eine imaginationsbasierte therapeutische Technik, die an belastenden autobiographischen Erinnerungen ansetzt, um psychopathologische Symptome bei verschiedenen psychischen Störungen zu reduzieren (Arntz, 2012; Holmes, Arntz, & Smucker, 2007). Beim ImRs werden Patient*innen zunächst dazu angeleitet, sich die belastende oder traumatische Erinnerung möglichst lebendig vorzustellen. In einem zweiten Schritt werden die Erinnerungen dann in der Imagination verändert, indem die negativen inneren Bilder in positivere umgewandelt werden. Ziel des ImRs ist es, die dysfunktionale Bedeutung von belastenden Erfahrungen zu verändern und dadurch intrusive Bilder, dysfunktionale Kognitionen sowie negative Emotionen zu reduzieren (Arntz, 2012; Morina, Lancee, & Arntz, 2017). ImRs wurde ursprünglich zur Behandlung von psychischen Störungen nach früher Traumatisierung in der Kindheit oder Jugend entwickelt (Arntz & Weertman, 1999; Smucker, Dancu, Foa, & Niederee, 1995), jedoch wurde das Anwendungsgebiet in den letzten Jahren deutlich erweitert. ImRs-Interventionen wurden seither in der Kognitiven Verhaltenstherapie verschiedener psychischer Störungen angewendet, wie beispielsweise zur Behandlung von Posttraumatischer Belastungsstörung (Arntz, Tiesma, & Kindt, 2007; Grunert, Weis, Smucker, & Christianson, 2007; Øktedalen, Hoffart, & Langkaas, 2015; Raabe, Ehring, Marquenie, Olff, & Kindt, 2015), sozialer Angststörung (z.B. Hyett et al., 2018; Lee & Kwon, 2013; McEvoy & Saulsman, 2014; Nilsson, Lundh, & Viborg, 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild & Clark, 2011), Depression (z.B., Brewin et al., 2009; Moritz et al., 2018), Persönlichkeitsstörungen (z.B. Arntz, 2011; Weertman & Arntz, 2007), sowie zur Behandlung von Alpträumen (z.B. Kunze, Arntz, Morina, Kindt, & Lancee, 2017).

Obwohl es Unterschiede zwischen den in verschiedenen Studien verwendeten Manualen gibt, stimmen die ImRs-Varianten in der grundlegenden Vorgehensweise überein, dass negative innere Bilder gemäß der individuellen Bedürfnisse der Patient*innen in hilfreichere Bilder umgewandelt werden (für einen Überblick siehe Holmes et al., 2007). Das häufig verwendete Manual nach Arntz und Weertman (1999) zur Behandlung von frühen traumatischen Erinnerungen unterteilt ImRs in die folgenden Phasen: In Phase 1 wird die Erinnerung emotional aktiviert, indem die damalige Situation aus der Perspektive des Kindes möglichst lebendig visualisiert wird. In Phase 2 werden die Patient*innen dazu angeleitet sich vorzustellen, dass sie als erwachsenes Ich die Situation betreten und zunächst beobachten, was dem Kind passiert. Darauffolgend wird das erwachsene Ich aufgefordert in der vorgestellten Situation zu intervenieren beispielsweise indem der/die Täter*in konfrontiert

und entmachtet und das Kind gerettet und unterstützt wird. In Phase 3 nehmen die Patient*innen nochmals die Perspektive des Kindes ein und erleben zunächst die in Phase 2 vom erwachsenen Ich durchgeführten Veränderungen der Situation. Zudem werden die Patient*innen dazu ermutigt, weitere noch offene Bedürfnisse oder Wünsche aus der Perspektive des Kindes zu verbalisieren (z.B. Trost, Ablenkung).

Ergebnisse einer aktuellen Meta-Analyse zeigen, dass ImRs-Interventionen eine wirksame Technik zur Behandlung verschiedener psychischer Störungen darstellen (Morina et al., 2017). Obwohl ImRs auf Grundlage der aktuellen Forschungsliteratur als vielversprechender transdiagnostischer Behandlungsansatz betrachtet werden kann, ist noch wenig über die zugrundeliegenden Wirkmechanismen bekannt.

Ziel der vorliegenden Arbeit war es daher, Wirkmechanismen von ImRs zu untersuchen. Analogstudien mit gesunden oder subklinischen Stichproben gelten als ein geeigneter Forschungsansatz, um in einem hochstandardisierten und kontrollierten Setting Mechanismen zu beleuchten, welche psychotherapeutischen Interventionen zugrunde liegen könnten (Scheveneels, Boddez, Vervliet, & Hermans, 2016; Van den Hout, Engelhard, & McNally, 2017). In Analogstudien werden psychopathologische Prozesse und deren therapeutische Behandlung bei gesunden Stichproben im Laborsetting modelliert, um eine systematische Untersuchung von Wirkprozessen auf zeit- und kosteneffektive Art und Weise zu erlauben (Scheveneels et al., 2016; Vervliet & Raes, 2013). Analogstudien im Bereich der ImRs-Forschung nutzten bislang hauptsächlich das sogenannte Traumafilm-Paradigma (TFP; für eine Übersicht siehe Holmes & Bourne, 2008; James et al., 2016), in welchem durch aversives Filmmaterial belastende Erinnerungen und Stresssymptome induziert werden, welche dann mit therapeutischen Interventionen verändert werden können (z.B. Dibbets & Arntz 2016; Dibbets, Lemmens, & Voncken, 2018; Hagenaars & Arntz 2012). Eine Einschränkung des TFP ist jedoch, dass die persönliche Relevanz der induzierten Erinnerungen begrenzt ist, da sie keine selbst-erlebten Ereignisse mit weitreichender Bedeutung für das Individuum umfassen. Außerdem enthalten Film-induzierte Erinnerungen typischerweise keine negativen Kognitionen über die eigene Person und sind selten mit Emotionen wie Schuld oder Scham assoziiert, die aber bei psychischen Störungen häufig eine große Rolle spielen (z.B. Beck et al., 2011; Kim, Thibodeau, & Jorgensen, 2011; Lee, Scragg, & Turner, 2001).

Um diesen Limitationen zu begegnen, wurde in der vorliegenden Arbeit eine Reihe von Analogstudien mit alternativen Untersuchungsparadigmen durchgeführt. Mögliche

Wirkmechanismen von ImRs wurden dabei im Kontext autobiographischer Erinnerungen an belastenden Lebensereignissen untersucht. Die betrachteten Erinnerungen sollten somit ein ökologisch valideres Modell jener Erinnerungen darstellen, welche in der klinischen Praxis mit ImRs behandelt werden.

Ziel von *Studie I* war es einerseits, ein neu entwickeltes Paradigma zur Untersuchung von ImRs bei autobiographischen Erinnerungen zu evaluieren. Zudem umfasste die Studie eine erste Untersuchung möglicher Wirkmechanismen von ImRs: Es wurde getestet, ob ImRs zu einer Veränderung der dysfunktionalen Bedeutung der Erinnerung („memory revaluation"; siehe Arntz, 2012) in Bezug auf das subjektive Kontrollerleben führt und negative Emotionen beim Erinnerungsabruf reduziert werden. Gesunde Studienteilnehmer*innen (N = 65), welche in den vergangenen 24 Monaten ein belastendes Lebensereignis erlebt hatten, wurden zufällig dem ImRs oder einer Kontrollgruppe ohne Intervention (KG) zugewiesen. Die aversive Erinnerung an das Lebensereignis wurde vor der Intervention/KG und zum Follow-up nach einer Woche reaktiviert, um die emotionale Reaktion beim Erinnerungsabruf zu erheben. Ebenso wurde die Belastungssymptomatik vor der Intervention und zum Follow-up-Zeitpunkt gemessen. Zusätzlich führten die Studienteilnehmer*innen ein Intrusionstagebuch während der einwöchigen Follow-up-Periode. Die Ergebnisse zeigten, dass die ImRs Gruppe weniger Intrusionen in der Woche nach der Intervention berichteten, jedoch war ImRs der KG bei der Reduktion der allgemeinen Belastungssymptomatik zum Follow-up Zeitpunkt nicht überlegen. Beim Erinnerungsabruf nach einer Woche berichtete die ImRs Gruppe eine stärkere Abnahme an Traurigkeit und Belastung sowie ein größeres Kontrollerleben als die KG.

In *Studie II* wurde das dargestellte Analogstudiendesgin aus *Studie I* optimiert, indem neben Selbstauskunftsmaßen auch die Messung physiologischer Reaktionen integriert wurde. Ziel der Studie war es, die Effekte von ImRs auf das subjektive Kontrollerleben und die emotionale Reaktion beim Erinnerungsabruf (siehe *Studie I*) unter Einbezug einer zusätzlichen aktiven Kontrollbedingung zu replizieren. Zudem hatte *Studie II* zum Ziel den bisherigen Forschungsstand zu erweitern, indem untersucht wurde, ob ImRs die physiologische Reaktion beim Erinnerungsabruf abschwächt. Gesunde Studienteilnehmer*innen (N = 79), welche Erinnerungen an ein belastendes Lebensereignis der letzten 24 Monate berichteten, wurden zufällig dem ImRs, einer positiven Imaginationsübung (PI) oder der KG zugewiesen. Die subjektive emotionale Reaktion sowie die physiologische Reaktion beim Erinnerungsabruf (Herzrate, elektrodermale Aktivität und

Elektromyographie) wurden vor der Intervention (bzw. PI, KG) und zum Follow-up nach einer Woche erhoben. Erwartungskonform führte ImRs zu einer größeren Abnahme der Belastung und negativen Emotionalität (Hilflosigkeit) beim Erinnerungsabruf als PI und KG. Jedoch war ImRs entgegen der Hypothese den Kontrollgruppen bei der Erhöhung des Kontrollerlebens nicht überlegen. Es wurde eine reduzierte physiologische Reaktion beim Erinnerungsabruf zum Follow-up Zeitpunkt festgestellt, wobei sich hier keine Gruppenunterschiede zeigten.

Die Ergebnisse der *Studien I* und *II* unterstützten die Annahme, dass ImRs zu einer Veränderung der (subjektiven) negativen emotionalen Qualität der Erinnerung führt (siehe Arntz, 2012). Die Frage, inwieweit die Erhöhung des Kontrollerlebens eine Rolle als Wirkmechanismus von ImRs spielt konnte aufgrund der dargestellten Befunde jedoch nicht eindeutig beantwortet werden. Ebenso bedarf es weiterer Forschung bezüglich der Effekte des ImRs auf durch die Erinnerung ausgelöste physiologische Reaktionen. Der vorgestellte analoge Forschungsansatz erscheint vielversprechend für zukünftige Forschung, jedoch sind Anpassungen notwendig um die klinische Wirksamkeit des ImRs auf Symptomebene reliabler abbilden zu können.

Um die Effekte des ImRs auf psychopathologische Symptome in einer analogen Stichprobe besser modellieren zu können, wurde in *Studie III* eine subklinische Stichprobe mit hoher Ausprägung sozialer Ängstlichkeit rekrutiert. Ziel von *Studie III* war es, einen weiteren potentiellen Wirkmechanismus von ImRs zu untersuchen: Verschiedene Autoren nehmen an, dass ImRs als imaginationsbasiertes Verfahren speziell über die Umbewertung dysfunktionaler *emotionaler* Überzeugungen wirken könnte („emotionally anchored reappraisal of dysfunctional beliefs“; siehe Nilsson et al., 2012; Norton & Abbott, 2016; Wild et al., 2008). Innere Bilder haben einen starken Einfluss auf emotionales Erleben und es wird daher vermutet, dass hilfreiche Bewertungen, die in der Form von Bilder generiert werden, emotional stärker verankert werden und glaubhafter sind als Bewertungen, die als rein verbale Repräsentationen dargeboten werden, zum Beispiel durch verbal-kognitive Interventionen wie der kognitiven Umstrukturierung (KU; Holmes & Mathews, 2010). *Studie III* untersuchte daher einerseits, ob ImRs zu einer Umbewertung dysfunktionaler *emotionaler* Überzeugungen führt und hatte andererseits zum Ziel, vorherige Befunde zu den Effekten des ImRs im Vergleich zur KU zu replizieren (Norton & Abbott, 2016). Hoch sozial ängstliche Proband*innen (N = 77) wurden zufällig einer Sitzung ImRs, KU oder einer KG (ohne Intervention) zugewiesen. Symptome sozialer Angst sowie idiosynkratische dysfunktionale

Überzeugungen (auf emotionaler und intellektueller Ebene) wurden vor den Interventionen (bzw. der KG) und zum Follow-up nach einer Woche erhoben. Die Ergebnisse zeigten, dass nur KU zu einer Abnahme von Symptomen sozialer Angst führte. Obwohl ImRs mit einer stärkeren Aktivierung positiver Emotionen während der Intervention einherging, berichteten Proband*innen der KU zum Follow-up einen stärkeren Rückgang emotionaler dysfunktionaler Überzeugungen. Damit konnten die vorliegenden Befunde die Annahme nicht unterstützen, dass eine Umbewertung dysfunktionaler *emotionaler* Überzeugungen ein Prozess ist, der speziell dem ImRs zugrunde liegt. Die Interpretation der Ergebnisse in Bezug auf mögliche Wirkmechanismen war jedoch eingeschränkt, da die klinische Wirksamkeit des ImRs auf Symptomebene in der untersuchten subklinischen Stichprobe nicht repliziert werden konnte.

Ziel der vorliegenden Arbeit war es, mit Hilfe verschiedener Analogstudien die Effekte und Wirkmechanismen von ImRs zu untersuchen. Dabei wurde den Limitationen vorheriger experimenteller Studien begegnet, indem ImRs im Kontext autobiographischer Erinnerungen an belastende Lebensereignisse untersucht. Die Ergebnisse zeigten, dass ImRs die Belastung beim Abruf aversiver autobiographischer Erinnerungen reduziert und negative Emotionen im Zusammenhang mit der Erinnerung abschwächt. Obwohl die vorgestellten Studien noch keine endgültigen Schlussfolgerungen über die dem ImRs zugrunde liegenden Wirkmechanismen erlaubten, lieferten sie dennoch neue Erkenntnisse über Untersuchungsparadigmen, die für zukünftige Forschung in diesem Bereich vielversprechend zu sein scheinen. Die vorliegende Arbeit stellte Implikationen für zukünftige Forschung zu Wirkmechanismen von ImRs-Interventionen dar und diskutierte das Potential und die Limitationen von Analogstudien im Bereich der ImRs-Forschung.

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Appendix A:

Supplementary Material *Study I*

Imagery Rescripting of Aversive Autobiographical Memories: Effects on Memory Distress, Emotions, and Feelings of Mastery

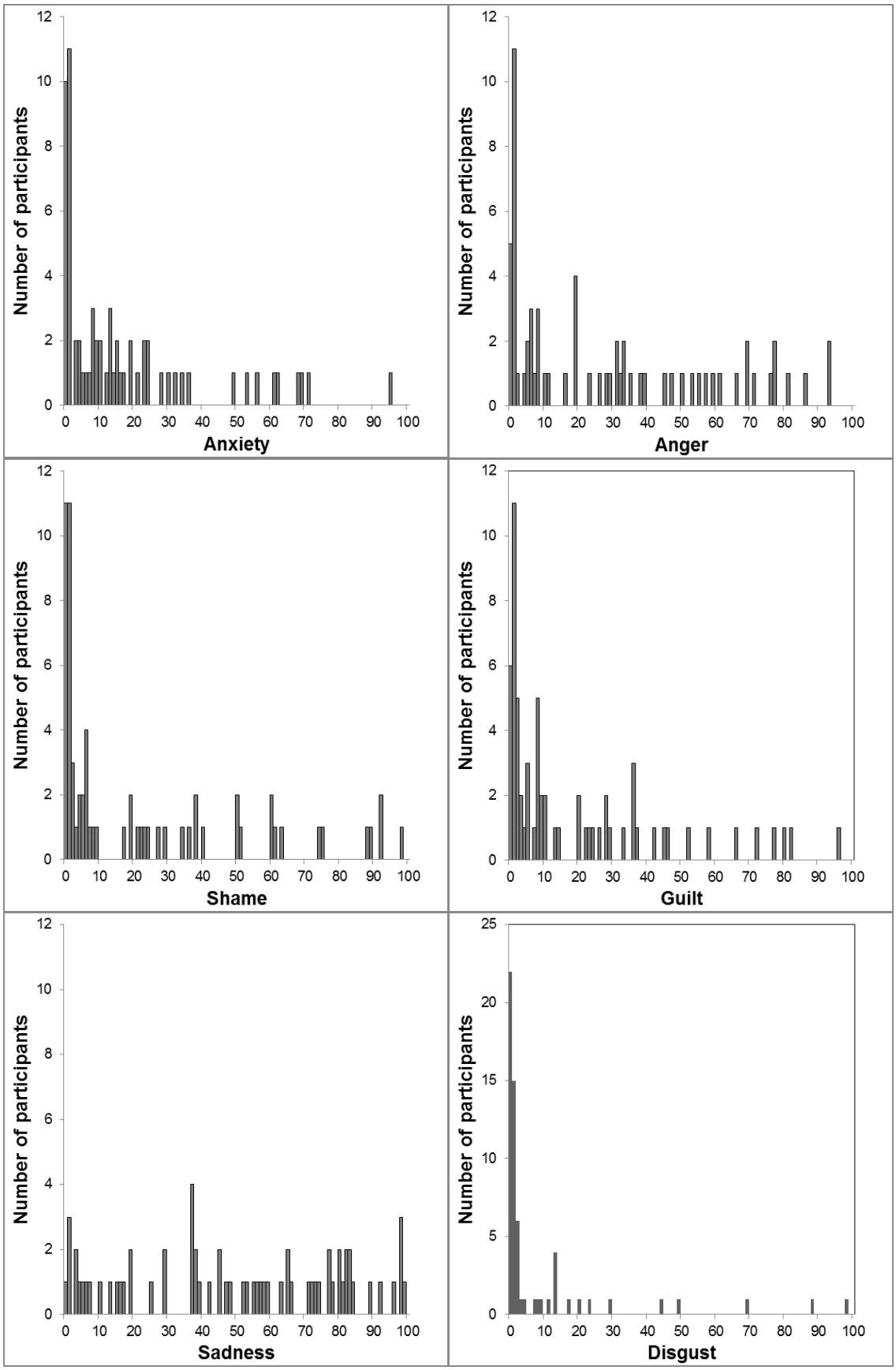

Figure A.1. Distributions of levels of negative emotions (anxiety, anger, shame, guilt, sadness, disgust) after memory reactivation (t1).

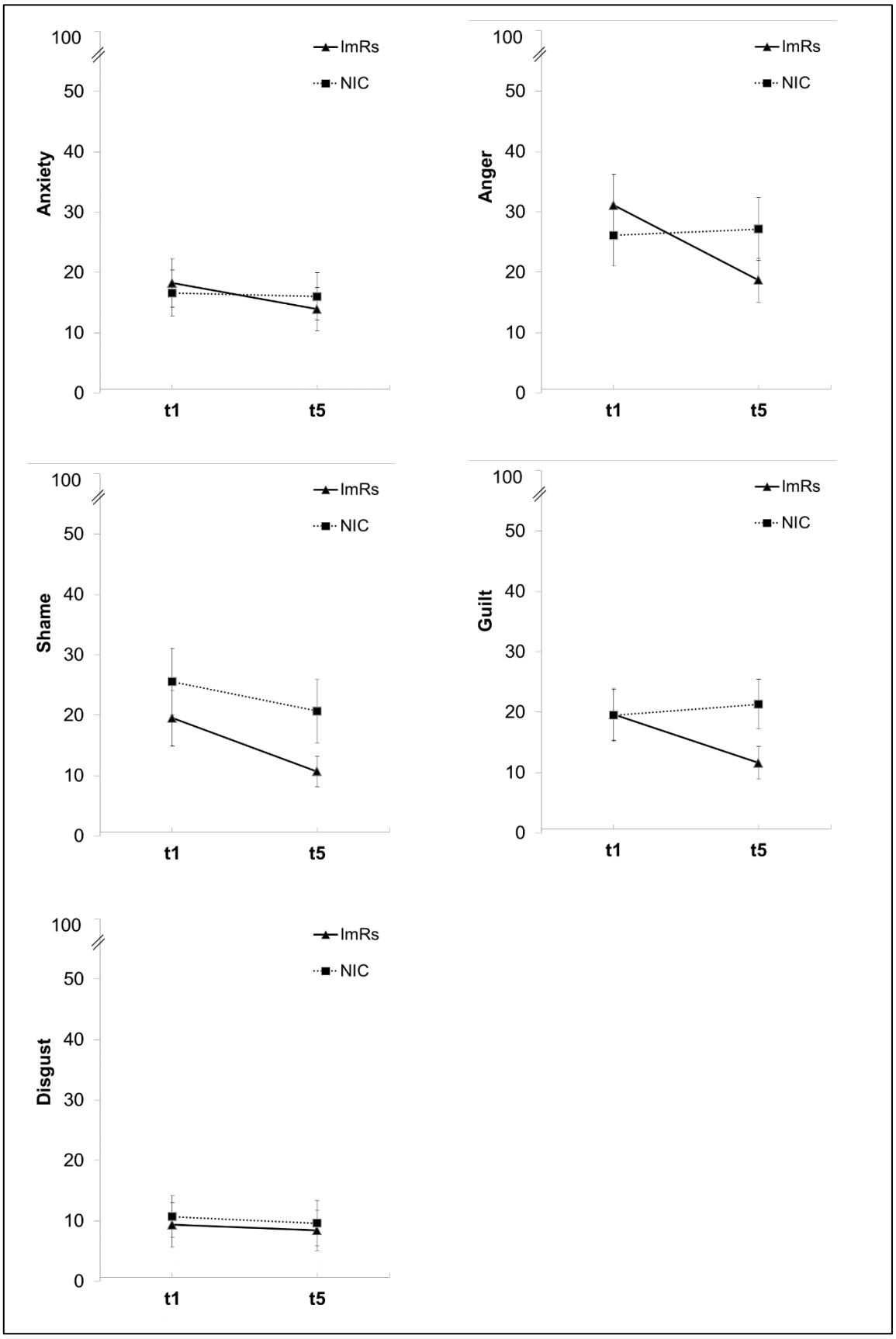

Figure A.2. Effects of imagery rescripting (ImRs) vs. no-intervention control condition (NIC) on negative emotions; t1: after memory reactivation task at baseline (before the intervention); t5: after memory reactivation task at follow-up (1 week after the intervention).

Table A.1.
Negative emotions: Means, standard deviations, main effects, and interaction effects.

	Group	Baseline (t1)	Follow up (t5)	Main effect		Interaction effect
		M (*SD*)	*M* (*SD*)	Condition F(1,63)	Time F(1,63)	Condition x Time F(1,63)
VAS Anxiety	ImRs	18.26 (22.24)	13.90 (20.07)	0.00	0.75	0.43
	NIC	16.59 (21.98)	16.00 (23.03)			
VAS Anger	ImRs	31.10 (28.28)	18.71 (20.22)	0.08	3.88	5.46*
	NIC	26.12 (29.21)	27.18 (30.30)			
VAS Shame	ImRs	19.55 (25.68)	10.71 (14.07)	1.73	6.58*	0.55
	NIC	25.59 (32.05)	20.71 (30.73)			
VAS Guilt	ImRs	19.65 (24.00)	11.61 (15.08)	0.86	2.12	5.34*
	NIC	19.50 (25.03)	21.32 (23.92)			
VAS Disgust	ImRs	9.35 (20.52)	8.42 (18.51)	0.07	0.38	0.00
	NIC	10.71 (20.32)	9.62 (21.95)			

Note: VAS = Visual analogue scale; ImRs = Imagery rescripting (n = 31); NIC = No-intervention control condition (n = 34).
*$p < 0.05$.

Table A.2.
Frequencies of intrusive memories

	Intrusive memories of the scene targeted in the study		Intrusive memories of other scenes of the event (not targeted in the study)		Intrusive memories of the ImRs
	ImRs	NIC	ImRs	NIC	ImRs
Intrusive memories, *n* (%)	45 (100)	115 (100)	59 (100)	36 (100)	7 (100)
Image[a]	23 (51.1)	43 (37.4)	22 (37.3)	19 (52.8)	3 (42.9)
Thought[a]	12 (26.7)	39 (33.9)	15 (25.4)	6 (16.7)	3 (42.9)
Combination (image and thought) [a]	10 (22.2)	33 (28.7)	22 (37.3)	11 (30.5)	1 (14.3)

Note: ImRs = Imagery rescripting (*n* = 31); NIC = no intervention control condition (*n* = 34).
[a] categorization based on participants' self-report in the intrusion diary

Appendix B:

Supplementary Material *Study II*

Imagery Rescripting of Aversive Autobiographical Memories: Psychological and Physiological Effects

Table B.1.
Means (SDs) of emotions and self-reported arousal in response to the memory reactivation task before (t0, t1) and after (t3, t4) the interventions.

	ImRs (*n* = 27)	**PI** (*n* = 25)	**NIC** (*n* = 27)
Negative emotions			
Anxious			
t0	21.13 (23.56)	14.88 (13.55)	22.84 (21.80)[a]
t1	43.81 (29.65)	35.12 (23.17)	34.16 (29.27)[a]
t3	13.41 (16.39)	25.43 (23.94)	17.89 (19.97)
t4	22.65 (26.24)	35.40 (25.84)	28.60 (25.91)
Angry			
t0	16.69 (23.04)	16.14 (25.08)	13.82 (22.51)[a]
t1	49.58 (30.77)	42.99 (28.39)	45.56 (36.92)[a]
t3	15.81 (19.49)	17.47 (16.99)	15.21 (19.56)
t4	34.06 (31.09)	37.45 (26.32)	42.96 (31.04)
Sad			
t0	28.58 (30.09)	38.70 (30.37)	41.92 (28.01)[a]
t1	69.86 (24.52)	71.39 (23.87)	72.31 (27.01)[a]
t3	20.43 (21.65)	30.14 (25.06)	24.71 (24.18)
t4	44.23 (30.89)	56.98 (25.73)	51.18 (29.99)
Guilty			
t0	21.91 (30.90)	13.98 (19.53)	18.59 (19.40)[a]
t1	41.66 (33.20)	36.72 (26.35)	38.44 (28.69)[a]
t3	11.51 (16.63)	21.05 (21.79)	11.88 (19.20)
t4	26.05 (25.45)	33.50 (25.00)	26.57 (29.16)
Helpless			
t0	15.28 (24.78)	29.62 (30.66)	28.87 (29.61)[a]
t1	57.39 (32.00)	63.17 (23.78)	54.42 (35.51)[a]
t3	16.51 (22.50)	27.54 (27.71)	14.57 (21.87)
t4	38.03 (33.33)	57.98 (24.30)	44.06 (34.83)
Positive emotions			
Happy			
t0	59.41 (18.84)	55.19 (16.80)	51.62 (22.22)[a]
t1	26.97 (17.52)	24.32 (18.22)	23.94 (20.64)[a]
t3	61.89 (16.53)	58.88 (18.60)	53.99 (22.41)
t4	43.15 (12.94)	38.42 (19.98)	32.23 (20.81)
Satisfied			
t0	61.83 (21.73)	56.04 (24.30)	52.97 (24.49)[a]
t1	29.41 (23.03)	24.82 (18.30)	24.39 (22.93)[a]
t3	63.71 (17.48)	54.01 (18.30)	52.91 (23.15)
t4	42.74 (15.41)	31.91 (20.87)	30.81 (22.89)
Proud			
t0	41.94 (23.68)	43.31 (21.48)	45.85 (25.70)[a]
t1	23.35 (24.60)	29.23 (25.63)	22.76 (24.60)[a]
t3	47.09 (20.58)	40.32 (25.54)	35.94 (27.35)
t4	38.07 (21.18)	28.00 (24.22)	25.04 (22.61)

Table B.1. (continued)

	ImRs (*n* = 27)	**PI** (*n* = 25)	**NIC** (*n* = 27)
Arousal			
SAM			
t0	4.23 (2.04)[a]	4.00 (1.85)	4.70 (1.92)
t1	7.04 (1.11)[a]	6.84 (1.89)	7.07 (1.88)
t3	3.70 (1.68)	3.64 (2.00)	3.85 (1.79)
t4	5.41 (1.76)	5.84 (1.86)	5.96 (1.85)

Note: ImRs = Imagery rescripting; PI = Positive imagery; NIC = No-intervention control condition; SAM = Self-Assessment Manikin.

[a] *n* = 26

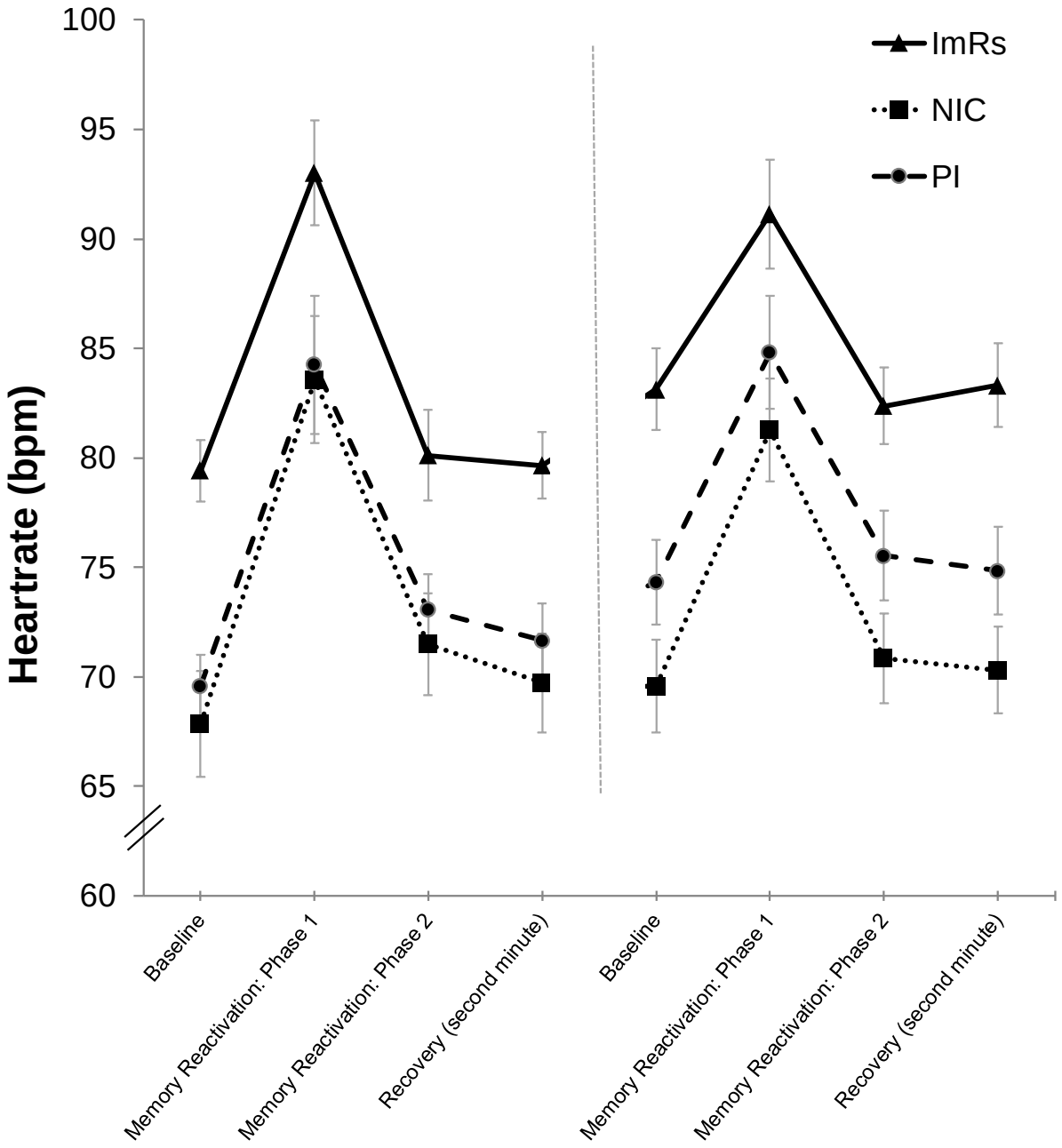

Figure B.1. Heartrate (bpm) during Session 1 and 2 in imagery rescripting (ImRs), positive imagery (PI) and no-intervention control group (NIC).

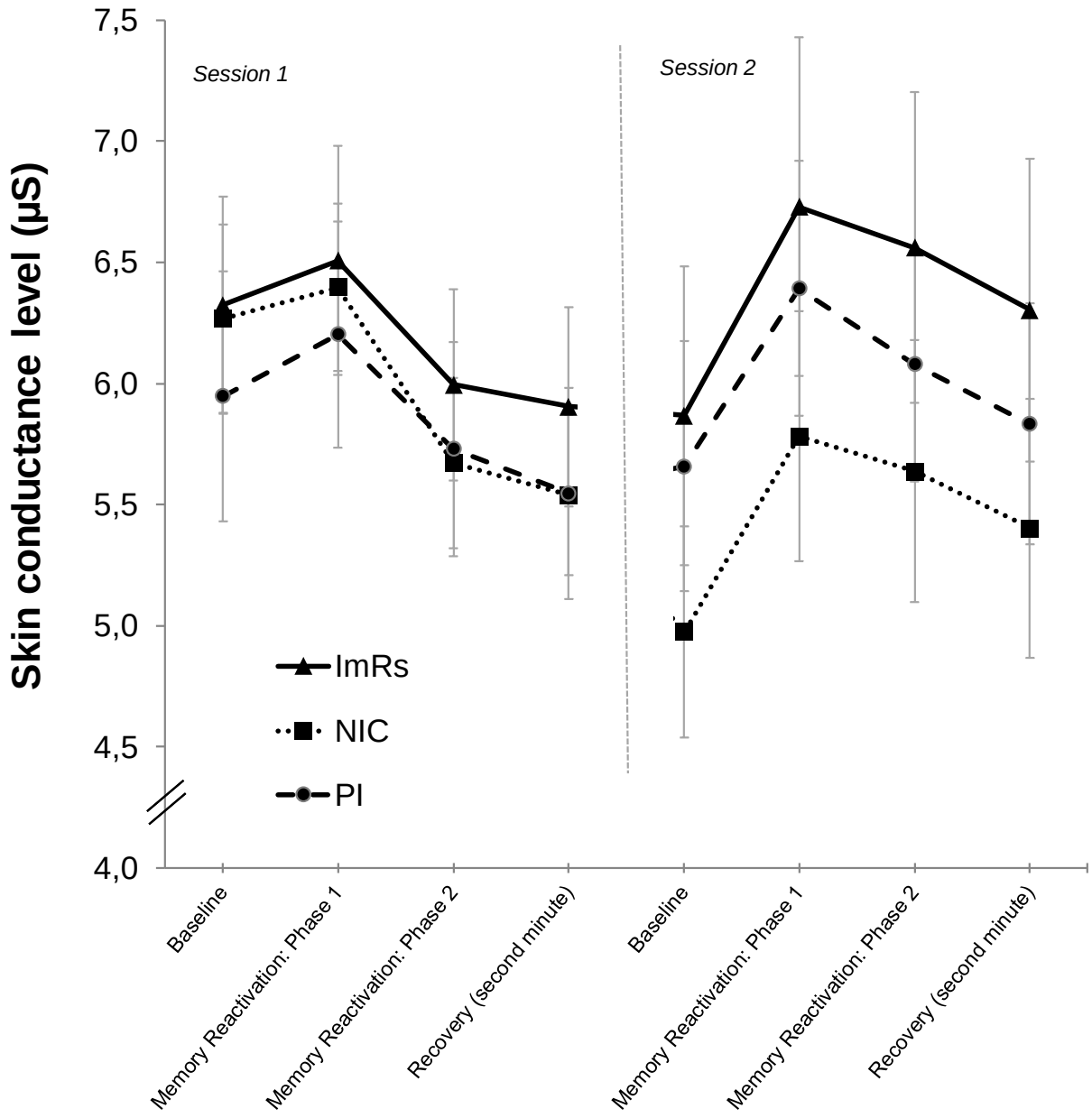

Figure B.2. Skin conductance level (µS) during Session 1 and 2 in imagery rescripting (ImRs), positive imagery (PI) and no-intervention control group (NIC).

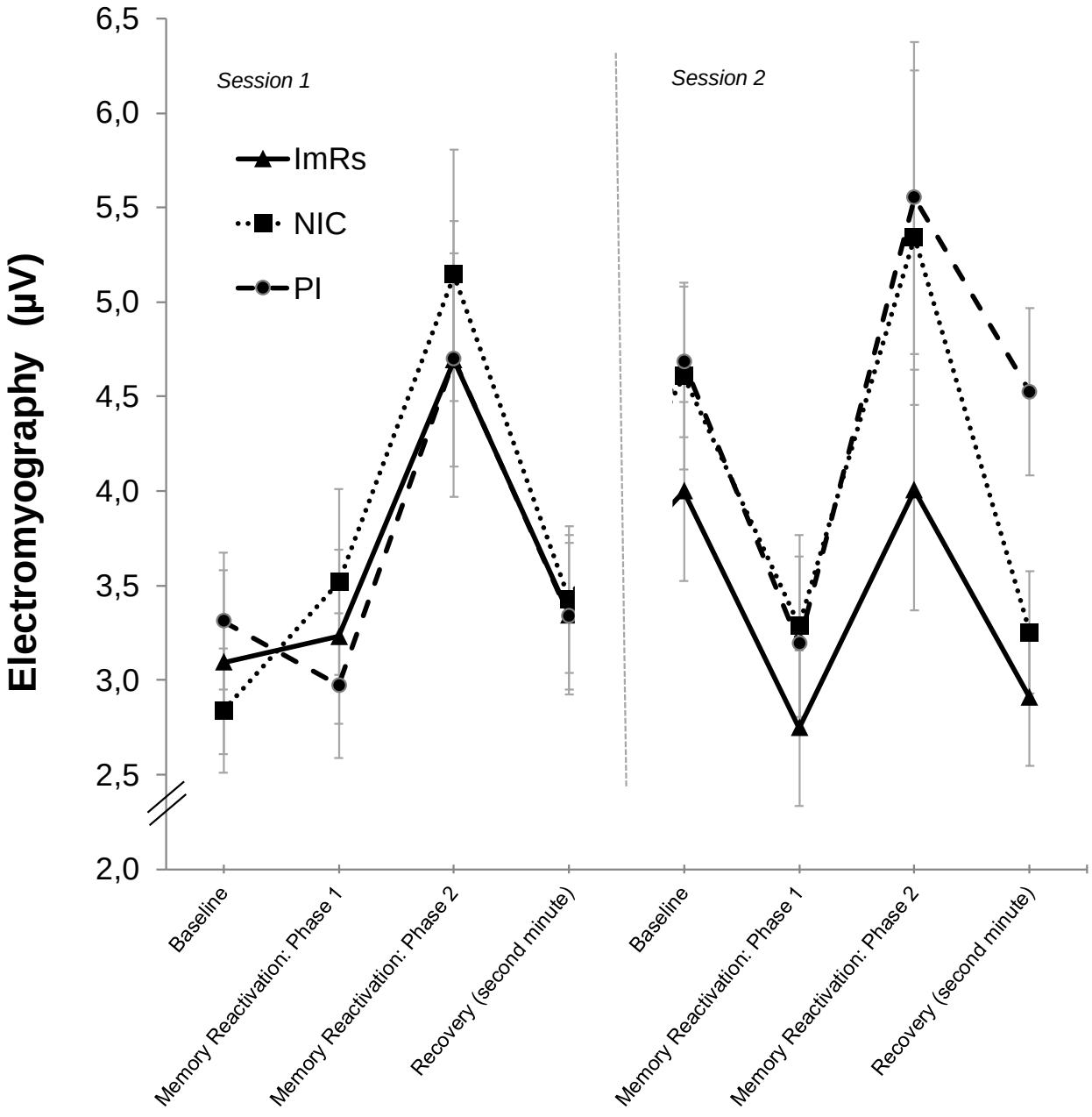

Figure B.3. Facial muscle activity of the *m. corrugator supercilii* (EMG in µV) during Session 1 and 2 in imagery rescripting (ImRs), positive imagery (PI) and no-intervention control group (NIC).

Appendix C:

Supplementary Material *Study III*

Imagery Rescripting versus Cognitive Restructuring for Social Anxiety: Treatment Effects and Working Mechanisms

Table C.1.
Positive and negative emotions: Means, standard deviations, main effects, and interaction effects.

	Group	Pre (t1)	Post (t2)	Main effect		Interaction effect
		M (*SD*)	*M* (*SD*)	Condition F(1,74)	Time F(1,74)	Condition x Time F(2,74)
PANAS-X: Basic negative emotion						
Fear	ImRs	13.32 (4.88)	9.32 (3.06)	0.25	74.36***	0.18
	CR	12.56 (4.50)	9.07 (3.28)			
	NIC	13.48 (4.26)	9.40 (3.35)			
Hostility	ImRs	7.64 (2.46)	7.08 (2.36)	1.17	11.28***	0.59
	CR	8.04 (3.78)	6.75 (2.30)			
	NIC	7.08 (1.73)	6.12 (0.33)			
Guilt	ImRs	12.36 (4.26)	7.88 (1.76)	0.17	37.00***	2.90 (p = .061)
	CR	10.78 (4.14)	8.93 (3.85)			
	NIC	10.76 (4.88)	8.44 (2.87)			
Sadness	ImRs	9.72 (4.34)	7.12 (2.86)	0.02	37.02***	0.40
	CR	9.30 (4.14)	7.48 (3.86)			
	NIC	9.44 (4.22)	7.08 (2.10)			
PANAS-X: Basic positive emotion						
Joviality	ImRs	14.68 (5.07)	22.72 (7.92)	2.06	71.39***	3.41*
	CR	14.56 (6.24)	19.81 (7.68)			
	NIC	13.61 (5.04)	17.36 (5.23)			

Table C.1 (continued)

	Group	Pre (t1)	Post (t2)	Main effect		Interaction effect
		M (*SD*)	*M* (*SD*)	Condition F(1,74)	Time F(1,74)	Condition x Time F(2,74)
Self-assurance	ImRs	9.84 (3.27)	15.52 (5.11)	2.35	61.23***	13.32***
	CR	10.85 (4.99)	13.89 (4.89)			
	NIC	10.12 (3.46)	10.72 (4.03)			
Attentiveness	ImRs	11.80 (2.18)	13.16 (2.98)	0.54	0.00	8.24***
	CR	11.74 (2.68)	11.89 (2.79)			
	NIC	12.64 (3.17)	11.08 (3.25)			

Note: PANAS-X = The Positive and Negative Affect Schedule -Extended; ImRs = Imagery rescripting (n = 25); CR = Cognitive restructuring (n = 27); NIC = No-intervention control condition (n = 25). *$p < 0.05$; *** $p \leq 0.001$.