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ORIGINAL ARTICLE

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 1 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.

Keywords Imagery rescripting · Emotional memories · Traumatic memories · Autobiographical memories · Mastery · Memory distress · Posttraumatic stress disorder

Introduction

Imagery rescripting (ImRs) has been shown to be a promising intervention for disorders associated with aversive emotional memories (Arntz 2012; Morina et al. 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 et al. 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 and 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 et al. 2016; Van den Hout et al. 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 and Raes 2013). Past analogue studies investigating ImRs were mainly based on the trauma film paradigm (TFP; for reviews, see Holmes and 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 and Arntz 2016; Hagenaars and Arntz 2012; Seebauer et al. 2014). However, some

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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 and Arntz 2016; Dibbets and 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 and 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 and 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 and Arntz 2016). In light of recent findings that ImRs might be superior to exposure-based interventions in targeting non-fear emotions (Arntz et al. 2007; Grunert et al. 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 et al. 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 and Kindt 2017; Schwabe et al. 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 and Arntz 2016; Dibbets et al. 2012; Hagenaars and 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., Çili et al. 2016; Slofstra et al. 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 et al. 2012; Reimer and 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 and 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 et al. 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 et al. 2004; Long and 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 et al. 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 et al. 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] 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.

[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.

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 (see "Procedure" section) 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 and 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 and 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 and 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 and Marmar 1997; German version: Maercker and Schützwohl 1998). The IES-R is a 22-item self-report questionnaire measuring posttraumatic symptoms over the past 7 days on three subscales: intrusions, avoidance, and hyperarousal. Based on the original English version of the IES-R (Weiss and 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 et al. 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 ($\kappa = .74$). 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 et al. 1988; German version: Krohne et al. 1996).

Procedure

The study comprised two sessions (conducted by the same experimenter), which were exactly 1 week apart. For an overview of the study procedure see Fig. 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,

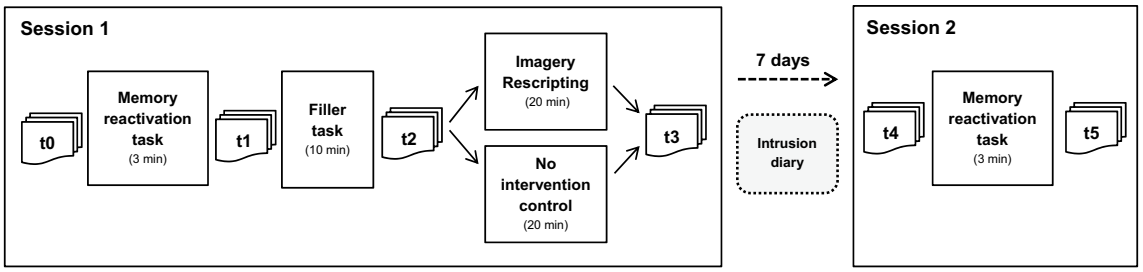

Fig. 1 Schematic overview of the study procedure. t0: M.I.N.I., structured interview on the distressing life-event, sociodemographic data, IES-R, intrusion questionnaire, PANAS, SUD, VAS negative emotions; t1: SUD, VAS negative emotions, mastery; t2: SUD, PANAS; t3: SUD, PANAS; t4: IES-R; t5: SUD, VAS negative emotions, mastery

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.

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) × 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 × 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 × 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 × 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 × Condition interaction effects (2 × 2 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.

Table 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)	$t(60)=-0.02$, $p=.99$

ImRs Imagery rescripting, *NIC* No-intervention control condition

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

Results

Participant Characteristics and Baseline Comparisons

Participants' demographic characteristics, baseline measures as well as characteristics of the distressing life-events are provided in Table 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. At baseline (t0) no significant differences between groups emerged on IES-R, PANAS, and SUD, all $ps > .386$.

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) × 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, $F(1, 63)=91.01$, $p<.001$, $\eta_p^2=.59$. No significant main effect of Condition and no significant interaction emerged, all $Fs(1, 63)<0.55$, $ps>.460$, $\eta_p^2<.009$. Results of a 2 (t0 vs. t1) × 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, $F(6, 58)=13.22$, $p<.001$, $\eta_p^2=.58$. Neither the main effect of Condition nor the interaction effect were significant, all $Fs(6, 58)<0.37$, $ps>.897$, $\eta_p^2<.037$. Separate univariate ANOVAs showed that there was an increase in all negative emotions over time, all $Fs(1, 63)>7.56$, $ps<.008$, $\eta_p^2>.11$, 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 Fig. 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.

Effects on Analogue Symptoms

Event-Related Stress Symptoms (Hypothesis 1)

Results of the 2 (t0 vs. t4) × 2 (ImRs vs. NIC) repeated measures ANOVAs revealed a significant main effect of Time for all three subscales of the IES-R, all $Fs(1, 63)>16.00$, $ps<.001$, $\eta_p^2>.21$, but neither significant main effects of Condition nor significant interactions, all $Fs(1, 63)<1.96$, $ps>.166$, $\eta_p^2<.03$.

Table 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)	

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]$n = 64$

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).

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.4 in the Supplementary Material.

Effects on Emotional Response to Memory Reactivation

Memory Distress (Hypothesis 3)

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

Memory-Related Negative Emotions (Hypothesis 4)

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

Mastery (Hypothesis 5)

The results of the 2 (t1 vs. t5) × 2 (ImRs vs. NIC) repeated measures ANOVA for mastery as dependent variable are

[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 Table A.2 and A.3 in the Supplementary Material.

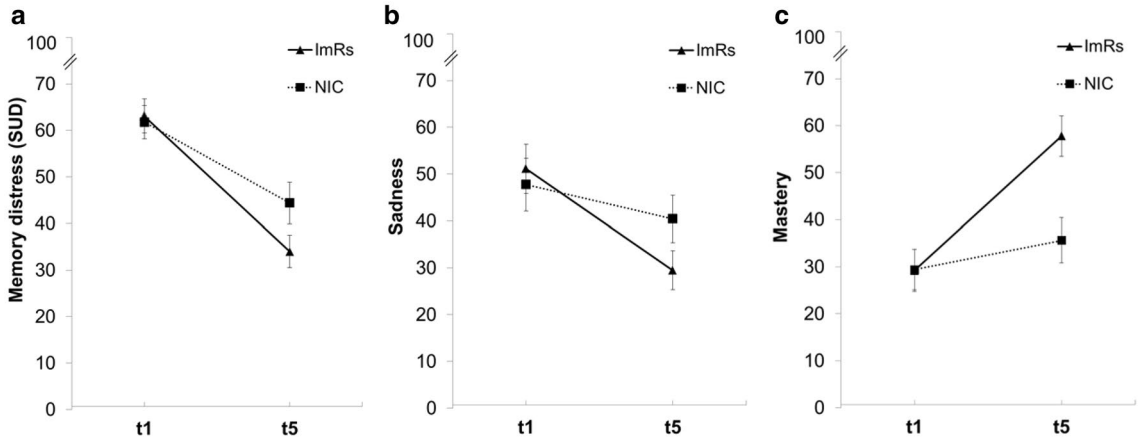

Fig. 2 Effects of Imagery rescripting (ImRs) versus no-intervention control condition (NIC) on **a** memory distress, **b** sadness, and **c** mastery; t1: after memory reactivation task at baseline (before the intervention); t5: after memory reactivation task at follow-up (1 week after the intervention); Error bars represent SEM

illustrated in Fig. 2. The significant main effects of Time, $F(1, 63) = 24.98$, $p < .001$, $\eta_p^2 = .28$, and Condition, $F(1, 63) = 4.31$, $p = .042$, $\eta_p^2 = .06$, were qualified by a significant interaction, $F(1, 63) = 10.29$, $p = .002$, $\eta_p^2 = .14$. As predicted, participants in the ImRs group reported significantly greater increases in mastery of the aversive situation in their memory.

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

Discussion

To address limitations of previous ImRs studies using the TFP (e.g., Dibbets and Arntz 2016; Hagenaars and 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 and 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 post-traumatic 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 and 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 and Arntz 2016; Hagenaars and 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 et al. 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 1 week compared to NIC. These findings replicate results of two earlier studies (Çili et al. 2016; Reimer and 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 and Schwartz 2002) or eye movement desensitisation and reprocessing (EMDR; e.g., Lee and 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 and 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 oneself, 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 and 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 et al. 2004; Long and 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 et al. 2019). 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 versus the older self's perspective as typically done in clinical protocols (e.g. Arntz and Weertman 1999; Wild and 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 and 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.

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Compliance with Ethical Standards

Conflict of Interest Miriam Strohm, Marena Siegesleitner, Anna E. Kunze, Thomas Ehring and Charlotte E. Wittekind declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Animal Rights This article does not contain any studies with animals performed by any of the authors.

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