J. Behav. Ther. & Exp. Psychiat. 43 (2012) 808–814

Contents lists available at SciVerse ScienceDirect

Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: www.elsevier.com/locate/jbtep

Reduced intrusion development after post-trauma imagery rescripting; an experimental study

Muriel A. Hagenaars[a,*], Arnoud Arntz[b]

[a] Department of Clinical, Health and Neuropsychology, Leiden University, PO Box 9555, 2300 RB Leiden, The Netherlands
[b] Department of Medical, Clinical and Experimental Psychology, PO Box 616, 6200 MD, Maastricht University, The Netherlands

ARTICLE INFO

Article history:
Received 7 January 2011
Received in revised form
19 May 2011
Accepted 5 September 2011

Keywords:
Imagery rescripting
PTSD
Intrusive memories
Intrusions
Prevention

ABSTRACT

Background and objectives: Contemporary theories predict PTSD development after trauma if trauma information is not adequately processed or negatively appraised. Mental imagery and emotional processing seem to be strongly related and evidence-based treatment strategies such as imaginal exposure and EMDR indeed include imagery as a main component. Moreover, imagery rescripting of traumatic memories is an effective treatment for PTSD.
Methods: The present study combined these lines of research and investigated the impact of early imagery rescripting on intrusion development after an aversive film. Seventy-six participants were randomly allocated to one of three conditions: imagery rescripting (IRS), imagery reexperiencing (IRE) and positive imagery (PI). All participants watched an aversive film, had a 30-min break and then received a 9-min intervention (IRS, IRE or PI). They indicated subjective distress during the intervention, recorded intrusive memories of the film for 1 week and completed the Posttraumatic Cognitions Inventory (PTCI) and a cued recall test one week later.
Results: The IRS group developed fewer intrusive memories relative to the IRE and PI groups, and less negative cognitions than the IRE group, while cued recall was enhanced in IRS and IRE groups compared to the PI group. IRS and PI groups experienced less distress during the intervention than the IRE group.
Limitations: This is an analogue design and results should be replicated in clinical samples.
Conclusions: The results suggest that IRS might be an adequate technique to change memory consolidation at an early stage and therefore a powerful and non-distressing strategy to prevent PTSD symptoms.

1. Introduction

Contemporary theories posit that at least part of the reason for someone to develop posttraumatic stress disorder (PTSD) after trauma lies in the fact that information is not adequately processed during and after trauma (Brewin, 2001; Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000). In other words, early information processing (i.e., encoding of trauma information) and the formation of an "inadequate trauma memory" (or "fear structure"; Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989) play a key role in the development of vivid reexperiences. Experimental studies indeed showed that factors affecting the encoding of trauma-related information, such as tonic immobility (Hagenaars, Van Minnen, Holmes, Brewin, & Hoogduin, 2008), visuospatial tasks (Holmes, Brewin, & Hennessy, 2004), or dissociation (Kindt, Van den Hout, & Buck, 2005) affected the development of intrusions. Moreover, clinical studies also found some of these peritraumatic factors, like tonic immobility (Heidt, Marx, & Forsyth, 2005) and dissociation (Ehlers, Mayou, & Bryant, 1998) to be related to subsequent PTSD development.

Treatments may be seen as reversing this process. That is, treatments that focus on changing the PTSD trauma memory structure prove successful in reducing PTSD symptoms, as is the case in imaginal exposure and EMDR treatments (e.g., Bradley, Green, Russ, Dutra, & Westen, 2005). Recently, a new technique called imagery rescripting was introduced. When combined with imaginal exposure, imagery rescripting proved as effective as imaginal exposure alone in changing PTSD symptoms, with fewer patients dropping out of treatment. Moreover, relative to pure imaginal exposure, patients also showed a greater decrease in anger, guilt and shame if imagery rescripting was added (Arntz, Tiesema, & Kindt, 2007). Imagery rescripting was also effective as treatment for snake phobia (Hunt & Fenton, 2007), intrusive

* Corresponding author. Tel.: +31 71 3613748; fax: +31 71 3615594.
E-mail addresses: mhagenaars@fsw.leidenuniv.nl (M.A. Hagenaars), arnoud.arntz@maastrichtuniversity.nl (A. Arntz).

0005-7916/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jbtep.2011.09.005

memories in depression (Brewin et al., 2009), and personality disorders (Weertman & Arntz, 2007).

In imagery rescripting, participants imagine different responses to and outcomes of the original event and its aftermath. A new script might include somebody else entering the scene and bringing safety, or the participant being in power and preventing the trauma, or taking revenge on perpetrators. Part of its effects might be explained by the healthy effects of expressing inhibited responses, and part by the adaptive effects of the change of meaning of the original event (Arntz, 2011; Arntz & Weertman, 1999; Arntz et al., 2007). In classical conditioning terms, imagery rescripting changes the UCS-UCR representation in memory by imagining more functional responses and outcomes to the original event. This so-called UCS/UCR revaluation changes the meaning of the fear memory underlying trauma-related symptoms (Arntz, 2011; Davey, 1989). By using imagery, the meaning change not only takes place on a verbal cognitive level, but also on sensory, emotional and behavioural levels.

By affecting imagery-based processing directly, imagery rescripting may not only serve treatment goals, but could also be an adequate tool in preventing the trauma-related, intrusive images from developing in the first place. There is some research suggesting the powerful effect of imagery on future behaviour and affect. For example, the ease of imagining the symptoms of a disease was associated with subsequent likelihood ratings of contracting that disease (Sherman, Cialdini, Schwartzman, & Reynolds, 1985). Interesting, similar findings were found with respect to positive affect. That is, participants imagining positive events reported greater increases in positive affect than participants thinking about the verbal meaning of that event. The former group also rated new descriptions as more positive than the latter (Holmes, Mathews, Dalgleish, & Mackintosh, 2006). Imagery can also alter judgements about past events (e.g., Garry, Manning, Loftus, & Sherman, 1996), again suggesting the relevance with respect to trauma and PTSD prevention.

Thus far, early post-trauma PTSD prevention strategies, like psychological debriefing, are often ineffective or even harmful (Wessely & Deahl, 2003). Early intervention may be a better strategy, although results with a brief cognitive therapy for persons with acute PTSD were not very promising in preventing chronic PTSD (Sijbrandij et al., 2007). Cognitive behavioural strategies were effective in acute stress disorder (e.g., Bryant, Moulds, Guthrie, & Nixon, 2003; Bryant, Moulds, Guthrie, & Nixon, 2005), but acute stress disorder is not necessarily predictive of PTSD (Bryant, Creamer, O'Donnell, Silove, & McFarlane, 2008). The early interventions that have been investigated thus far mainly focus on exposure to traumatic memories and/or cognitive restructuring. Imagery rescripting may be a fruitful alternative. Besides the strong association between imagery and affective processing (Hagenaars, Brewin, Van Minnen, Holmes, & Hoogduin, 2010), the rescripting part may lead to altered encoding and consolidation of trauma information (e.g., feelings of mastery associated with the new script become linked to the trauma information). This may result in the development of other sorts of memories in the first place and therefore lead to more positive affect and (trauma-related) cognitions. In the present study manipulations were done 30 min after analogue trauma for this reason. That is, memory consolidation is still in progress at that point (Dudai, 2004), meaning that the memory is still labile and sensitive to change. Also, practically, as our manipulations were new, we wanted to keep their timing in accordance with previous experimental studies that found effects of manipulations conducted 30 min post-stressor on the development of intrusive memories (Holmes, James, Coode-Bate, & Deeprose, 2009; Holmes, James, Kilford, & Deeprose, 2010).

The present study explores whether imagery rescripting affects intrusion development using an experimental trauma film paradigm. Participants were randomized over three post-film conditions: imagery rescripting (IRS), imagery reexperiencing (IRE) and positive imagery (PI). IRE and PI were used as control conditions in order to control for the effects of imagery (both IRE and PI), the effects of re-activating the memory of the film (IRE), and the effect of positive imagery and positive mood (PI). First, IRS participants were expected to report less distress during the intervention than IRE participants, because they had to concentrate on a positive outcome after retrieving the memory of the aversive film. In addition, it was hypothesized that the IRS condition would be associated with fewer intrusive memories of the film and less negative cognitions compared to the other experimental groups. Because IRS and IRE both involved active reprocessing of film material, and PI did not, we expected that IRS and IRE groups would both have enhanced explicit memory of the movie compared to PI. With both IRS and IRE showing enhanced explicit memory, differences between these conditions on intrusions and negative cognitions would not be related to explicit memory.

2. Method

2.1. Participants

Eighty-three students were recruited at Leiden University campus and completed the screening phase. Seven participants were excluded because they experienced road traffic accidents ($n = 3$), or suffered from a mood or anxiety disorder ($n = 4$), leaving a total sample of 76 participants (29 males). Age ranged from 18 to 38 ($M = 21.4$ years, $SD = 4.0$). All participants gave written informed consent and received course credits or cash money for their participation.

2.2. Material

A 10-min film was used to model a traumatic experience. The film consisted of four traumatic scenes of real-life footage of the horrible aftermath of road traffic accidents, such as dead bodies being moved, injured victims, and car wrecks. Following Hagenaars et al. (2008), one scene was removed from the original 5 scenes compiled by Steil (1996).

2.3. Measures

2.3.1. Psychiatric symptoms

The 12 screening items of the Structured Clinical Interview for DSM-IV (SCID-I; Spitzer, Williams, Gibbon, & First, 1992) were used to assess psychiatric symptoms. The SCID-I is a standardised, semi structured, diagnostic interview for diagnosing DSM-IV psychiatric disorders, which has good reliability (overall kappas were .61 for current and .68 for lifetime diagnosis). Diagnoses were checked using the relevant SCID-I sections if participants endorsed symptoms on one of the items.

2.3.2. Mood ratings

Participants indicated how anxious, horrified, sad and angry they felt before and after watching the film and before and after the interventions on a scale from 0 ("not at all") to 10 ("extremely"), to check the emotional impact of the film and the interventions.

2.3.3. Distress

Participants rated the amount of distress they felt on a scale from 0 (no distress) to 10 (extreme distress) before the 9-min intervention, and every 3 min after it had started, resulting in 4 SUD scores per person.

2.3.4. Intrusive memories

For seven days after the film, participants recorded every intrusion of the film using a tabular diary (see also Brewin & Saunders, 2001; Davies & Clark, 1998; Holmes et al., 2004). To check the intrusive character, participants had to describe the content of each intrusion, and indicate how spontaneous it was. Verbal and written instructions were given about the nature of involuntary intrusions and how to keep the diary. Intrusive images were described as "spontaneously occurring" rather than deliberate memories of the film. The importance of recording every intrusion was emphasised. As an extra check for compliance participants had to send an email at the end of each day with the number of intrusions they had experienced that day. Following Davies and Clark (1998) to check diary compliance at follow-up, participants rated how often they forgot or were unable to record intrusions from 0 (never) to 10 (always). The total number of intrusions was calculated by a rater that was blind to group membership, by adding up all intrusive images (not thoughts) in the diary. Intrusive images were selected because dominant sensory processing is considered to play a role in the development of PTSD (Arntz, De Groot, & Kindt, 2005; Brewin, Dalgliesh, & Joseph, 1996; Ehlers & Clark, 2000), which has indeed been shown by a dominant presence of images in PTSD reexperiences (Ehlers et al., 2002) and analogue intrusions (Hagenaars et al., 2010). A second rater (AA, also blind to group membership) calculated the intrusion frequency of a random sub-sample ($n = 15$) in order to establish interrater reliability, which proved excellent (ICC = .997).

2.3.5. Negative cognitions

Negative cognitions were assessed using the Posttraumatic Cognitions Inventory (PTCI; Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). The 33 PTCI items are rated on a 7-point scale (1 = "totally disagree" to 7 = "totally agree"). The items can be classified into three categories: negative cognitions about the self (Negative Self, 21 items), negative cognitions about the world (Negative World, 7 items), and Self-Blame (5 items). The total PTCI score is the sum of all 33 items, mean scores are used for subscale-totals. All three subscales show an excellent internal consistency (alpha = .97, .88 and .86 respectively; alpha = .97 for the total score) and good test-retest reliability ($\rho = .75$, .89 and .89 respectively; $\rho = .74$ for the total score).

2.3.6. Explicit memory

Explicit memory of the film was assessed using a cued recall test (Hagenaars et al., 2008; Holmes et al., 2004), consisting of 12 open-ended questions. Answers were compared to a list of correct answers, and rated correct or incorrect by a blind rater. A second blind rater judged a random sub-sample ($n = 15$), resulting in a 100% interrater reliability (ICC = 1.00). A correct-ratio was calculated by dividing the number of correct answers by the total number of questions, resulting in a ratio ranging from 0 to 1, with higher scores indicating more correct answers.

2.4. Procedure

After screening by an independent experimenter participants were randomly allocated to one of three conditions: positive imagery (PI; $n = 27$), imagery reexperiencing (IRE; $n = 25$), and imagery rescripting (IRS; $n = 24$). Except for the intervention, the procedure was the same for all conditions. Participants completed the mood ratings after the screening phase, and received instructions for watching the film (emphasizing that they had to imagine they were present at the scene and that they were not allowed to close their eyes or look away). They were observed during the film from behind a one-way screen to ascertain they adhered to the instructions and kept their attention to the film.[1] After watching the film, they once more completed the mood ratings, after which they had a 30 min break. [2] Participants again completed mood ratings and were informed about the intervention after they returned from their break. Instructions were similar across conditions except for the crucial details that distinguished the interventions from each other. That is, all participants were instructed to close their eyes and picture scenes of the film (IRS and IRE) or a recent positive event (PI) in as much detail as possible. They had to imagine that they were experiencing the scene here and now and had to focus on sensory details, such as images, sounds, smells, physical feelings, and emotions. Applying the instructions normally used in imaginal exposure treatment, participants had to talk in the first person and in the present tense in order to increase vividness and involvement (Dancu & Foa, 1993). Two independent experimenters facilitated this process by asking specific questions about sensory details and subjective emotions in all conditions. The focus of the interventions was the following:

2.4.1. Positive imagery

Participants had to select a personal, pleasant experience and recall and reexperience this event following the method described above.

2.4.2. Imagery reexperiencing

Participants were instructed to recall and reexperience a scene from the film following the method described above.

2.4.3. Imagery rescripting

Participants were instructed to recall and reexperience a scene from the film for the first 3 min. Then, participants had to change the event into something that they wished had happened. This new script was then imagined following the method described above so that the outcome resulting in a more satisfying outcome (according to the participant). Participants could make any script they liked, being realistic (for example by introducing doctors in the scene that could rescue the victims) or unrealistic (for example by introducing superman).

All interventions lasted 9 min. Participants indicated their distress during the intervention while keeping their eyes closed. The experimenter wrote down the main theme of the scripts for each participant. After the intervention, participants completed mood ratings and intrusion diaries were explained.

Participants completed the PTCI and memory questionnaire one week later. They then handed in their Intrusion Diaries which were discussed with a fourth independent experimenter.

3. Results

Two participants were identified as univariate outliers with more than 3 standard deviations above the mean. Their scores were changed into a score that was one unit higher next most extreme

[1] Observed behaviours were subsequently coded into 4 categories: movement (e.g., picking clothes), facial expressions (e.g. disgust), looking away (e.g., not looking at the screen for a moment), and N/A (nothing remarkable noticed). Only 3 participants looked away at some point during the film, and there were no differences between conditions in any of the observed behaviours ($\chi^2(6, N = 76) = 2.25$, $p = .90$).

[2] Participants were asked for their activities during the break, which were subsequently categorized (e.g., studying, reading). Chi square analyses showed that conditions did not differ in activity type during the break (χ^2 (8, $N = 76$) = 5.19, $p = .74$).

score in the distribution, so that the between-subject order remained the same (Tabachnick & Fidell, 1996). Effect sizes (Cohen's d and partial η^2) are reported for all outcomes.

Paired samples *t*-tests yielded significant pre-film to post-film increases in anxiety, horror, sadness, and anger (all $t(75) < -5.08$, all $ps < .001$), with a main increase in horror (from .46 pre-film to 5.75 post-film) indicating the film was quite horrifying. A 2 (Time) × 3 (Condition) repeated measures analysis of variance (ANOVA) showed no Time x Condition effect ($F(2, 73) < .83$ and $p > .44$ for all emotions) demonstrating that there were no differences between conditions in emotional impact of the film.

3.1. Distress during the intervention

A repeated measures ANOVA was done with Time (mood pre and post intervention) as within-subjects variables and Condition as between-subjects factor to test whether PI, IRE, and IRS had a different emotional impact (see Table 1 for means). This should be reflected in a Time × Condition interaction, which was indeed significant for all emotions, indicating that conditions had a different effect on mood (all $Fs(2, 72) > 3.26$, all $ps < .05$, all $\eta_p^2 s > .08$). Posthoc tests showed pre to post increases in anxiety, horror, and sadness after IRE (all $ps < .03$; no increase in anger), no pre to post changes in any emotion after IRS (all $ps > .33$), and pre to post decreases in anxiety, horror, and sadness after PI (all $ps > .05$; no decrease in anger). In sum, PI reduced negative emotions, IRE increased negative emotions, and IRS did not change levels of negative emotions.

Group differences in subjective distress during the intervention were calculated using repeated measures ANOVA with Time (distress at 4 times) as within-subjects variable and Condition as between-subjects factor. Time, Condition, and the Time × Condition effects were all significant ($F(3, 71) = 6.31$, $p = .01$, $\eta_p^2 = .08$; $F(2, 73) = 5.86$, $p = .004$, $\eta_p^2 = .14$; and $F(6, 144) = 3.86$, $p = .03$, $\eta_p^2 = .10$, respectively, see Fig. 1), indicating group differences in distress over time. Posthoc LSD comparisons showed that on average, participants in the IRS and PI groups experienced less distress during the intervention than those in the IRE groups ($p = .03$, $d = .64$ and $p = .003$, $d = .87$ respectively). Mean distress in the IRS and PI groups did not differ significantly ($p = .40$, $d = .24$). Interestingly, pair wise comparisons on the different time points showed that distress in the IRS group was lower than in the IRE group at 6 and 9 min (both $ps < .03$), but not at 0 and 3 min (both $ps > .13$), when rescripting had not started yet. Distress did not differ between the IRS and PI groups at any time point (all $ps > .10$), whereas distress was lower in the PI group than in the IRE group at any time point (all $ps < .05$) (Table 1).

Table 1
Means (SDs) of the outcome measures in the positive imagery (PI), imagery reexperiencing (IRE) and imagery rescripting (IRS) groups.

	PI ($n = 27$)	IRE ($n = 25$)	IRS ($n = 24$)
Mean distress*	2.05 (2.11)	3.85 (2.39)	2.54 (1.57)
Intrusive memories*	4.74 (5.54)	6.20 (5.84)	1.96 (2.14)
Number of participants with no intrusive memories (%)*	7 (26%)	3 (12%)	11 (46%)
PTCI			
Self	1.39 (.31)	1.58 (.48)	1.41 (.33)
World*	2.79 (1.19)	3.14 (.93)	2.31 (.72)
Self-blame*	1.49 (.54)	2.07 (.90)	1.61 (.76)
Total*	56.15 (13.61)	65.12 (15.53)	55.45 (13.67)
Cued recall (correct ration)*	.49 (.18)	.60 (.15)	.59 (.14)

PI = Positive Imagery. IRE = Imagery Reexperiencing. IRS = Imagery rescripting. PTCI = Posttraumatic Cognitions Inventory. *P*-values indicate overall group differences.
*$p < .05$.

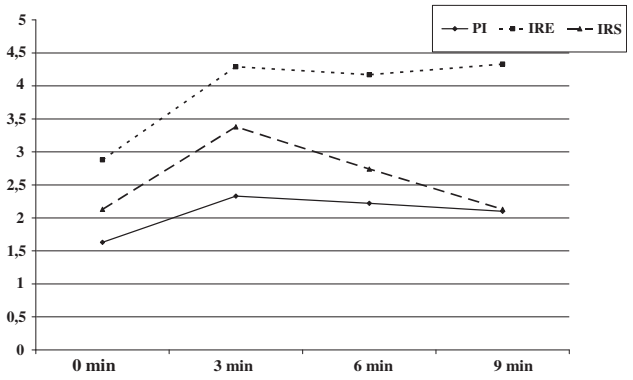

Fig. 1. Subjective distress during the intervention in the positive imagery (PI), imagery reexperiencing (IRE) and imagery rescripting (IRS) groups.

3.2. Intrusive memories

Univariate ANOVAs showed that the frequency of intrusive memories significantly differed between groups ($F(2, 73) = 4.64$, $p = .01$, $\eta_p^2 = .11$, see Table 1 and Fig. 2, Panel A). Posthoc comparisons showed that participants in the IRS condition experienced fewer intrusive memories of the film than those in the PI and IRE conditions ($p = .047$, $d = .57$ and $p = .004$, $d = .87$ respectively). There were no differences between PI and IRE groups ($p = .29$, $d = .30$).

Of the total sample, 20 participants (27%) experienced no intrusions at all. There were significantly more participants in the IRS ($n = 11$, 46%) than in the PI ($n = 7$, 26%) and IRE ($n = 3$, 12%) groups that experienced no intrusive memories ($\chi^2(2, N = 76) = 6.25$, $p = .044$, see Fig. 2, Panel B).

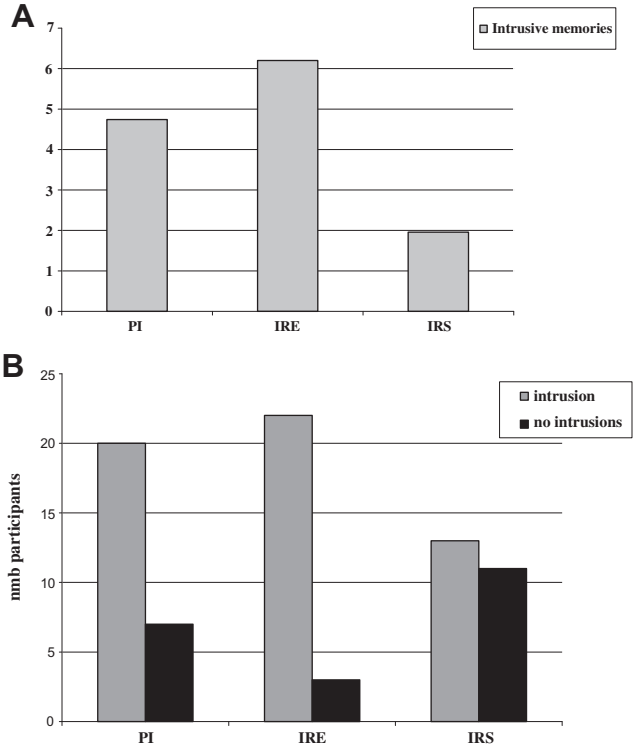

Fig. 2. Panel A. Intrusion frequency in the positive imagery (PI), imagery reexperiencing (IRE) and imagery rescripting (IRS) groups, Panel B. Percentage of participants that experienced no intrusive memories at all.

3.3. Dysfunctional trauma-related cognitions

An ANOVA yielded a significant Group effect on PTCI Total ($F(2, 73) = 3.53$, $p = .04$, $\eta_p^2 = .09$; see Table 1). Posthoc comparisons showed that PTCI Total was lower in the IRS and PI groups compared to the IRE group ($p = .02$, $d = .68$ and $p = .03$, $d = .63$ respectively). IRS and PI groups did not differ significantly ($p = .86$, $d = .05$).

Univariate ANOVAs were subsequently run to detect which subscales were responsible for the group difference. These revealed yielded significant effects for Negative World ($F(2, 73) = 3.87$, $p = .023$, $\eta_p^2 = .10$) and Self-Blame ($F(2, 73) = 3.33$, $p = .04$, $\eta_p^2 = .09$), but not for Negative Self ($F(2, 73) = .61$, $p = .55$, $\eta_p^2 = .02$). Posthoc comparisons showed that Negative World was lower in the IRS group compared to the IRE group ($p = .005$, $d = .85$). The IRS group tended to score lower on Negative World than the PI group ($p = .09$, $d = .49$), whereas IRE and PI groups ($p = .20$, $d = .36$) did not differ significantly. Self-blame was lower in the IRS group ($p = .04$, $d = .62$) and the PI group ($p = .007$, $d = .78$) than in the IRE group. PI and IRS groups did not differ in Self-Blame ($p = .57$, $d = .16$).

3.4. Cued recall

An ANOVA revealed a significant Group effect on cued recall ($F(2, 73) = 3.50$, $p = .04$, $\eta_p^2 = .09$; see Table 1). Posthoc comparisons showed that cued recall was enhanced in the IRS ($p = .03$, $d = .63$) and IRE groups ($p = .02$, $d = .69$) relative to the PI group, whereas IRS and IRE groups did not differ from each other ($p = .83$ $d = .06$), suggesting enhanced explicit memory in the two experimental conditions that included a film-related intervention.

3.5. Imagery rescripting strategies

Participants in the IRS condition indicated to have used the following rescripting strategies: the accident was prevented ($n = 6$), the accident or subsequent injuries were less serious ($n = 5$), the patient was treated and recovered ($n = 5$), the patients or dead bodies were treated with more respect ($n = 6$), fantasy scripts (e.g., "blood goes back inside the leg"; $n = 2$).

A univariate ANOVA with the five script categories as independent variable (Script) and intrusion frequency as dependent variable yielded no effect of Script ($F(4, 19) = 1.24$, $p = .33$, $\eta_p^2 = .22$), indicating that script type was not related to intrusion frequency. However, different script types were associated with the presence of absence of intrusive memories ($\chi^2(5, N = 24) = 11.04$, $p = .03$). Those who used scripts that included prevention of the trauma more often had no intrusive memories of the film ($n = 5$, 83%) than those with other scripts (accident less serious: $n = 0$, 0%; patient treated: $n = 2$, 40%; more respect: $n = 3$, 50%; fantasy: $n = 0$, 0%).

Participants in the PI group used the following events for their imagery: vacation ($n = 9$), sports ($n = 6$), social event ($n = 5$), exam ($n = 2$), and various (e.g., new job, sun bathing; $n = 4$). An ANOVA revealed no effect of Event on intrusion frequency ($F(4, 22) = 1.7$, $p = .19$, $\eta_p^2 = .25$). Neither were event types associated with the presence or absence of intrusive memories ($\chi^2(5, N = 27) = 6.91$, $p = .14$).

4. Discussion

The present study investigated the impact of a 9-min imagery rescripting intervention on the development of intrusive memories after an aversive film. To our knowledge, this is the first study that explores the mechanisms of imagery rescripting and its effect on intrusion development in a controlled experimental design.

The main finding of the present study was that the imagery rescripting group experienced fewer intrusive memories relative to the other two groups. This is a promising finding with practical and theoretical implications. Practically, imagery rescripting may be a useful strategy for preventing the development of PTSD after trauma. Prevention interventions have not been very promising thus far, or even harmful (Wessely & Deahl, 2003). Possibly, the reason for this is that prevention requires different techniques than treatment. That is, strategies that have proven to be effective in treatment, such as exposure, may not lead to improvement when applied briefly after trauma. Alternatively, exposure may need longer sessions (than our 9 min) or more session (than for example Sijbrandij et al., 2007) in order for within or between session habituation to take place. Imagery rescripting may target another working mechanism by altering encoding or storage of trauma information, which might positively affect the formation of a trauma memory very early. That is, information of the actual event may be stored similarly, but after imagery rescripting, this information is associated with different response information (such as feelings of mastery, positive affect, cognitions of one-self being in control), and thus different meanings. Remarkably, imagery rescripting led to fewer intrusive memories than positive imagery. The positive imagery intervention did not involve trauma-processing as it was completely unrelated to the film. It therefore resembles avoidance strategies, whereas imagery rescripting might work by the combination of reexperiencing the trauma and changing its meaning. Contemporary theories of PTSD have indeed suggested that appraisal mechanisms are responsible for the development of PTSD (Ehlers & Clark, 2000).

The fact that imagery rescripting participants developed fewer intrusive memories than the other groups and more often had no intrusive memories at all, may also have theoretical implications. Several experimental studies have shown that participants develop fewer intrusive memories if they are involved in interventions that need working memory capacity while watching a trauma film (Holmes et al., 2004; Krans, Näring, & Becker, 2010). A recent study found that participants executing a 10-min visuospatial task 30 min after an aversive film experienced to fewer intrusions in the subsequent week relative to a no-task control group (Holmes et al., 2009), although the no-task control group may have been reexperiencing the film spontaneously, as they were instructed to sit still for 10 min after being reminded of the film by the presentation of film-stills. All conditions in the present study consist of similar interventions in terms of duration and – presumably – working memory load. In addition, the control conditions control for imagery (IRE and PI), activation of the trauma information (IRE), and PI. This may strengthen the conclusion that in order to change consolidation and/or reconsolidation of trauma information, one needs to activate the trauma information (done in imagery reexperiencing and imagery rescripting) and at the same time change it (done in imagery rescripting). The control conditions suggest that imagery rescripting does not work by mere activation of trauma information or mere positive imagery. Note the resemblance with the emotional processing theory (Foa & Kozak, 1986; Foa et al., 1989), which posits that the fear structure must be activated and new incompatible information should be added in order for a treatment to be effective.

In line with this, imagery rescripting also led to less self-blame and fewer negative cognitions about the world than imagery reexperiencing, and even tended to lead to fewer dysfunctional cognitions about the world than positive imagery. Thus, the rescripting part of the imagery rescripting intervention may protect against the development of negative appraisals. Our hypothesis that imagery rescripting leads to fewer dysfunctional cognitions than the other two conditions was rejected with respect to the positive imagery condition. A closer inspection of the data revealed a floor effect, with both the imagery rescripting and positive

imagery groups having very low scores especially on self-blame. Possibly, self-blame may not be applicable to a laboratory setting with analogue trauma. As we did found less self-blame after imagery rescripting than after imagery reexperiencing, this remains an empirical question, though. According to Arntz and Weertman (1999) and Arntz (2011) imagery rescripting alters the meaning of the original event by changing the original responses to and the negative associations of the unconditioned stimulus into more positives ones. Interestingly, our data suggest that it may be relevant how the original event is changed, as scripts that included prevention of the accident were most successful. Disruption of reconsolidation processes with pharmacological intervention has been shown to lead to changes in fear expression and return of fear (Kindt, Soeter, & Vervliet, 2009). Our data may indicate that this process can also take place after a psychological intervention, although future research should include a non-intervention control group to test whether imagery rescripting is more effective than what people would spontaneously do. It would also be interesting check whether changes in attribution would be reflected in the development of intrusive thoughts.

Interestingly, participants in the imagery rescripting condition experienced little distress during the intervention. That is, distress levels were comparable with an intervention consisting of reexperiencing a positive event and lower than an intervention consisting of reexperiencing the trauma film. In fact, distress levels dropped after the reexperiencing part of the imagery rescripting intervention was finished and the rescripting part had started. Reexperiencing of a traumatic event indeed elicits distress in PTSD patients, be it spontaneous reliving or reliving as part of a therapeutic intervention (e.g., in imaginal exposure). Arntz et al. (2007) compared imagery rescripting combined with imaginal exposure with imaginal exposure alone and found that the latter approach lead to more dropout. Although not assessed in that study, higher levels of subjective distress may be responsible for this higher dropout rate. Subjective distress or symptom exacerbation were also associated with decreased perceived suitability for imaginal exposure treatment, even though this evidence-based treatment is the first treatment of choice for PTSD (Van Minnen, Hendriks, & Olff, 2010). Imagery rescripting combines the powerful impact of imagery with focussing on positive, yet trauma-related, aspects (Holmes, Arntz, & Smucker, 2007), and as such, it may be an effective and less stressful alternative. Interestingly, the conditions also had a different effect on mood: in addition to experiencing more distress during imagery reexperiencing, this intervention also evoked negative emotions. In contrast, negative emotions were reduced after positive imagery, underscoring the validity of this condition as a pleasant intervention. Imagery rescripting did not cause any changes in mood, which might be reasonable given that participants activate the memory of the aversive event (unpleasant), after which this event is altered (pleasant). Interestingly, these differences indicate that in our study imagery rescripting was not effective by eliciting positive mood.

Finally, enhanced explicit memory was not responsible for the effects of IRS, as IRE and IRS groups both showed enhanced cued recall compared to PI. As both make use of recalling the original event, this may have improved encoding of the trauma information compared to the not film-related positive imagery intervention. Thus, our data indicate that intrusive memories do not develop as a result of enhanced or impeded explicit memory, possibly indicating that these are two distinct phenomena. They also indicate that imagery rescripting does not work by changing memories of what actually happened.

The present study used a 30-min break in order to resemble real-life post-trauma situations as much as possible. It is not clear, though, in which time-window interventions are most effective. Future studies should vary the time between the film and the intervention to determine the interval in which the interventions are effective. We did not include a non-intervention control group, because such a group would have to come to the laboratory as well, in order to rule out effects of attention and laboratory exposure, factors that would otherwise complicate comparisons between the experimental groups and the control group. However, such a control group (waiting in the laboratory for the duration of the intervention) also complicates interpretations because the laboratory setting may serve as a reminder of the films and participants would probably have spontaneous reexperiences of the film, or try to avoid thinking about it by focussing on something else. Thus, such control condition does not seem to validly represent non-intervention. We therefore restricted our control conditions to two. However, future research should include preferably two non-intervention control groups (one waiting in the laboratory and one going home) to check whether imagery rescripting is more effective than "life as usual". Furthermore, as the effects of imagery rescripting proved promising in a controlled experimental setting, the intervention should also be investigated as a prevention strategy after a real trauma in a randomized controlled trial. Finally, note that the imagery reexperiencing intervention is not similar to reliving the trauma as is done in imaginal exposure treatment. That is, in such an early stage after trauma, memory consolidation and reconsolidation is still in progress, whereas in treatment, trauma memories have already been (re)consolidated. Thus, reliving may be harmful briefly after trauma, whereas it can be curative and even change the trauma memory once flashbacks have been developed.

In conclusion, this experimental study showed that imagery rescripting might be a promising strategy after trauma, preventing intrusive memories from developing. It was superior to a distracting strategy of positive imagery, which created little distress on the short-term, but did not prevent later intrusions. It was also superior to imagery reexperiencing, both in short-term and long-term effects. Thus, imagery rescripting seems to combine the advantages of less distress during processing, good memory consolidation with respect to actual trauma information, fewer post-trauma intrusions and less dysfunctional trauma-related cognitions. Imagery rescripting may change the memory of the trauma in an early stage, possibly by adding positive response information and attributions to the trauma memory, making it an important topic for future research.

Acknowledgements

M. Hagenaars was supported by VENI Grant (#016.105.142) from the Netherlands Organization for Scientific Research (NWO). The authors kindly thank Merel Dangeau, Jan Essink, Anke de Moor, and Ivor Vink for their help during the data collection.

References

Arntz, A. (2011). Imagery rescripting for personality disorders. *Cognitive and Behavioral Practice, 18*, 466–481.

Arntz, A., Groot de, C., & Kindt, M. (2005). Emotional memory is perceptual. *Journal of Behavior Therapy and Experimental Psychiatry, 36*, 19–34.

Arntz, A., Tiesema, M., & Kindt, M. (2007). Treatment of PTSD: a comparison of imaginal exposure with and without imagery rescripting. *Journal of Behavior Therapy and Experimental Psychiatry, 38*, 345–370.

Arntz, A., & Weertman, A. (1999). Treatment of childhood memories; theory and practice. *Behaviour Research and Therapy, 37*, 715–740.

Bradley, R., Green, J., Russ, E., Dutra, L., & Westen, D. (2005). A multidimensional meta-analysis of psychotherapy for PTSD. *American Journal of Psychiatry, 162*, 214–227.

Brewin, C. R. (2001). A cognitive neuroscience account of posttraumatic stress disorder and its treatment. *Behaviour Research and Therapy, 39*, 373–393.

Brewin, C. R., Dalgliesh, T., & Joseph, S. (1996). A dual representation theory of posttraumatic stress disorder. *Psychological Review, 103*, 670–686.

Brewin, C. R., & Saunders, J. (2001). The effect of dissociation at encoding on intrusive memories for a stressful film. *British Journal of Medical Psychology, 74*, 467–472.
Brewin, C. R., Wheatley, J., Patel, T., Fearon, P., Hackmann, A., Wells, A., et al. (2009). Imagery rescripting as a brief stand-alone treatment for depressed patients with intrusive memories. *Behaviour Research and Therapy, 47*, 569–576.
Bryant, R. A., Creamer, M., O'Donnell, M. L., Silove, D., & McFarlane, A. C. (2008). A multisite study of the capacity of acute stress disorder to predict post-traumatic stress disorder. *Journal of Clinical Psychiatry, 69*, 923–929.
Bryant, R. A., Moulds, M., Guthrie, R., & Nixon, R. D. V. (2003). Treating acute stress disorder following mild traumatic brain injury. *American Journal of Psychiatry, 160*, 585–587.
Bryant, R. A., Moulds, M., Guthrie, R., & Nixon, R. D. V. (2005). The additive effect of hypnosis and cognitive-behavioral therapy in treating acute stress disorder. *Journal of Clinical and Consulting Psychology, 73*, 334–340.
Dancu, C. V., & Foa, E. B. (1993). Cognitive-behavior therapy with posttraumatic stress disorder. In A. Freeman, & F. M. Dattilio (Eds.), *Casebook in cognitive therapy*. New York: Plenum.
Davey, G. C. L. (1989). UCS revaluation and conditioning models of acquired fears. *Behaviour Research and Therapy, 27*, 512–528.
Davies, M., & Clark, D. (1998). Predictors of analogue post-traumatic intrusive cognitions. *Behavioural and Cognitive Psychotherapy, 26*, 303–314.
Dudai, Y. (2004). The neurobiology of consolidations, or, how stable is the engram? *Annual Review of Psychology, 55*, 51–86.
Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38*, 319–345.
Ehlers, A., Hackmann, A., Steil, R., Clohessy, S., Wenniger, K., & Winter, H. (2002). The nature of intrusive memories after trauma: the warning signal hypothesis. *Behaviour Research and Therapy, 40*, 995–1002.
Ehlers, A., Mayou, R. A., & Bryant, B. (1998). Psychological predictors of chronic posttraumatic stress disorder after motor vehicle accidents. *Journal of Abnormal Psychology, 107*, 508–519.
Foa, E. B., Ehlers, A., Clark, D. M., Tolin, D. F., & Orsillo, S. M. (1999). The post-traumatic cognitions inventory (PTCI): development and validation. *Psychological Assessment, 11*, 303–314.
Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: exposure to corrective information. *Psychological Bulletin, 99*, 20–35.
Foa, E. B., Steketee, G., & Rothbaum, B. O. (1989). Behavioral/cognitive conceptualizations of posttraumatic stress disorder. *Behavior Therapy, 20*, 155–176.
Garry, M., Manning, C. G., Loftus, E. F., & Sherman, S. J. (1996). Imagination inflation: imagining a childhood event inflates confidence that it occurred. *Psychonomic Bulletin & Review, 3*, 208–214.
Hagenaars, M. A., Brewin, C. R., Van Minnen, A., Holmes, E. A., & Hoogduin, C. A. L. (2010). Intrusive images and thoughts after an aversive film. *Memory, 18*, 76–84.
Hagenaars, M. A., Van Minnen, A., Holmes, E. A., Brewin, C. R., & Hoogduin, C. A. L. (2008). The effect of hypnotically-induced somatoform dissociation on intrusion development after an aversive film: an experimental study. *Cognition and Emotion, 22*, 944–963.
Heidt, J. M., Marx, B. P., & Forsyth, J. P. (2005). Tonic immobility and childhood sexual abuse: a preliminary report evaluating the sequela of rape-induced paralysis. *Behaviour Research and Therapy, 43*, 1157–1171.
Holmes, E. A., Arntz, A., & Smucker, M. R. (2007). Imagery rescripting in cognitive behaviour therapy: images, treatment techniques and outcomes. *Behaviour Research and Therapy, 38*, 297–305.
Holmes, E. A., Brewin, C. R., & Hennessy, R. G. (2004). Trauma films, information processing and intrusive memory development. *Journal of Experimental Psychology: General, 133*, 3–22.
Holmes, E. A., James, E. L., Coode-Bate, T., & Deeprose, C. (2009). Can playing the computer game "tetris" reduce the build-up of flashbacks for trauma? A proposal from cognitive science. *PLoS ONE, 4*, 1–6.
Holmes, E. A., James, E. L., Kilford, E. J., & Deeprose, C. (2010). Key steps in developing a cognitive vaccine against traumatic flashbacks: visuospatial tetris versus verbal pub quiz. *PloS ONE, 5*, 1–9.
Holmes, E. A., Mathews, A., Dalgleish, T., & Mackintosh, B. (2006). Positive interpretation training: effects of mental imagery training versus verbal training on positive mood. *Behavior Therapy, 37*, 237–247.
Hunt, M., & Fenton, M. (2007). Imagery rescripting versus in vivo exposure in the treatment of snake fear. *Journal of Behavior Therapy and Experimental Psychiatry, 38*, 329–344.
Kindt, M., Soeter, M., & Vervliet, B. (2009). Beyond extinction: erasing fear responses and preventing return of fear. *Nature Neuroscience, 12*, 256–258.
Kindt, M., Van den Hout, M., & Buck, N. (2005). Dissociation related to subjective memory fragmentation and intrusions, but not to objective memory disturbances. *Journal of Behavior Therapy and Experimental Psychiatry, 36*, 43–59.
Krans, J., Näring, G., & Becker, E. S. (2010). Count out your intrusions: effects of verbal encoding on intrusive memories. *Memory, 17*, 809–815.
Sherman, S. J., Cialdini, R. B., Schwartzman, D. F., & Reynolds, K. D. (1985). Imagining can heighten or lower the perceived likelihood of contracting a disease: the mediating effect of ease of imagery. *Personality and Social Psychology Bulletin, 11*, 118–127.
Sijbrandij, M., Olff, M., Reitsma, J. B., Carlier, I. V. E., De Vries, M. H., & Gersons, B. P. R. (2007). Treatment of acute posttraumatic stress disorder with brief cognitive behavioral therapy: a randomized controlled trial. *American Journal of Psychiatry, 164*, 82–90.
Spitzer, R. L., Williams, J. B., Gibbon, M., & First, M. B. (1992). The structured clinical interview for DSM-III-R (SCID). I: history, rationale, and description. *Archives of General Psychiatry, 49*, 624–629.
Steil, R. I. (1996). *Posttraumatische Intrusionennach Verkehrsunfällen*. [*Posttraumatic intrusions after road traffic accidents*]. Frankfurt, Germany: Peter Lang.
Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics* (3rd ed.). New York: Harper Collins.
Van Minnen, A., Hendriks, L., & Olff, M. (2010). When do trauma experts choose exposure therapy for PTSD patients? A controlled study of therapist and patient factors. *Behaviour Research and Therapy*, 312–320.
Weertman, A., & Arntz, A. (2007). Effectiveness of treatment of childhood memories in cognitive therapy for personality disorders: a controlled study contrasting methods focusing on the present and methods focusing on childhood memories. *Behaviour Research and Therapy, 45*, 2133–2143.
Wessely, S., & Deahl, M. (2003). Psychological debriefing for PTSD: psychological debriefing is a waste of time. *British Journal of Psychiatry, 183*, 12–14.