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Efficacy of imagery rescripting and imaginal exposure for nightmares: A randomized wait-list controlled trial



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ABSTRACT

Nightmares can be effectively treated with cognitive-behavioral therapies. Though it remains elusive which therapeutic elements are responsible for the beneficial effects on nightmare symptoms, imagery rescripting (IR) and imaginal exposure (IE) are commonly identified as active treatment components of nightmare therapies. With this randomized controlled trial, we compared IR and IE as individual treatments to a wait-list (WL) condition to determine whether these particular therapeutic elements ameliorate nightmare symptoms. For this purpose, 104 patients with a primary DSM-5 diagnosis of nightmare disorder were randomly assigned to three weekly individual sessions of either IR or IE, or WL. Results showed that compared to WL, both interventions effectively reduced nightmare frequency ($\Delta d_{IR-WL} = 0.74$; $\Delta d_{IE-WL} = 0.70$) and distress ($\Delta d_{IR-WL} = 0.98$; $\Delta d_{IE-WL} = 1.35$) in a sample that predominantly consisted of idiopathic nightmare sufferers. The effects of IR and IE were comparable to those observed for other psychological nightmare treatments. Initial effects at post-treatment were sustained at 3- and 6-months follow-up, indicating that IR and IE both seem to be efficacious treatment components of nightmare therapies. Additional research is needed to directly compare IR and IE among both idiographic and posttraumatic nightmare sufferers with respect to treatment expectancy, acceptability, and effectiveness.

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1. Introduction

Nightmares can be defined as extremely dysphoric dreams that typically involve hazards to an individual's survival, security, or emotional or physical integrity (American Psychiatric Association [APA], 2013). Nightmares usually occur during rapid eye movement sleep and often awake the individual from sleep. Upon awakening, individuals quickly become oriented, alert, and conscious of their surroundings. According to the 5th edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-5; APA, 2013), individuals with nightmares qualify for the diagnosis 'nightmare disorder' if the experienced nightmares cause substantial daytime suffering and distress.

Approximately 2–5% of the general population report to have

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one or more nightmares per week (Li, Zhang, Li, & Wing, 2010; Sandman et al., 2013; Schredl, 2010). In psychiatric populations, the prevalence is much higher, with up to 30% of patients suffering from frequent nightmares (Swart, van Schagen, Lancee, & van den Bout, 2013). Recurrent nightmares are often related to considerable suffering and distress (Lancee & Schrijnemaekers, 2013; Nielsen & Levin, 2007; Spoomaker, Schredl, & Bout, 2006), and they are further associated with various forms of psychopathology (Spoomaker & van den Bout, 2005) such as anxiety, depression, posttraumatic stress disorder (PTSD), suicidal ideation, substance abuse (Nielsen & Levin, 2007), and personality disorders (Schredl, 2016).

Cognitive-behavioral therapy is currently the treatment of choice for recurrent nightmares (Lancee, Spoomaker, Krakow, & van den Bout, 2008; Spoomaker & van den Bout, 2005), with imagery rehearsal therapy (IRT) being the most empirically supported treatment format (Augedal, Hansen, Kronhaug, Harvey, & Pallesen, 2013; Hansen, Höfling, Kröner-Borowik, Stangier, & Steil, 2013; Lancee et al., 2008) with moderate (Hansen et al., 2013) to

large effect sizes (Krakow et al., 2001). In IRT (e.g., Krakow & Zadra, 2006, 2010), patients are asked to change (rescript) the storyline of a particular nightmare into an alternative and less distressing story, and to subsequently rehearse the new nightmare script in their imagination during the day. IRT successfully decreases nightmare frequency and distress (Augedal et al., 2013; Hansen et al., 2013) and improves sleep quality and posttraumatic stress disorder complaints in patients with comorbid PTSD and nightmare disorder (Casement & Swanson, 2012; Krakow et al., 2001). In addition to IRT, exposure techniques are effective in the treatment of nightmares. During exposure for nightmares, patients are confronted with the content of their nightmares in written reports and/or their imagination. Exposure-based nightmare treatments can reduce nightmare frequency and intensity in face-to-face (Cellucci & Lawrence, 1978; Miller & DiPilato, 1983) and self-help formats (Burgess, Gill, & Marks, 1998; Grandi, Fabbri, Panattoni, Gonnella, & Marks, 2006; Lancee, Spormaker, & van den Bout, 2010).

Given that rescripting and exposure are central elements of various therapeutic protocols, they have been recognized as the active treatment components of nightmare therapy (Hansen et al., 2013). However, identifying the active ingredients of existing nightmare treatments poses a methodological challenge, because the most widely used formats of IRT and IE for nightmares consist of multiple components (Hansen et al., 2013). For example, rescripting-based treatment protocols such as IRT (Krakow & Zadra, 2006, 2010) and exposure-based protocols (e.g., Burgess et al., 1998; Lancee et al., 2010) both comprise treatment elements such as extensive psycho-education about sleep and nightmares, relaxation and safe-place exercises, and nightmare journals. In particular cases, rescripting and exposure are even directly combined (e.g., Exposure, Relaxation, and Rescripting Therapy (ERRT); Davis & Wright, 2006, 2007; Long et al., 2011). Knowledge about the therapeutic role of rescripting and exposure in nightmare treatments is currently limited and empirical data are lacking (Hansen et al., 2013). In an effort to extend this knowledge base, Pruiksma et al. (2016) recently showed that ERRT is not more effective with rescripting and exposure as it is without these treatment components. The results demonstrate that even though most nightmare treatments rely on the therapeutic efficacy of rescripting and/or exposure (at least from a theoretical perspective), it remains unclear whether rescripting and exposure are in fact active treatment components of nightmare therapies, or whether other aspects of nightmare treatments might be responsible for ameliorating nightmare symptoms.

With the present study, we aimed to investigate the isolated therapeutic efficacy of rescripting- and exposure-based treatments for idiopathic and posttraumatic nightmares. In order to dissect their therapeutic effects as stand-alone treatment elements, we intended to demonstrate their superiority to no-treatment separately. For this purpose, we developed two treatment protocols, which exclusively consist of either imagery rescripting (IR) or imaginal exposure (IE). In a randomized controlled trial, we examined the efficacy of three weekly individual sessions of IE and IR compared to a wait-list (WL) control group. In line with previous findings (Augedal et al., 2013; Hansen et al., 2013), we hypothesized that both treatments would effectively decrease nightmare symptoms (i.e., nightmare frequency and distress) from pre- to post-treatment assessment, when compared to WL. Secondary outcomes included sleep disturbances and PTSD related symptoms, which have previously been shown to be ameliorated by nightmare treatments (Casement & Swanson, 2012). Given that dysfunctional beliefs are known to play an important role in sleep disorders (Lancee, Eisma, van Straten, & Kamphuis, 2015), we also measured dysfunctional beliefs about nightmares. We further tested whether treatment gains of IR and IE would be maintained at 3- and 6-

months follow-up.

2. Method and materials

2.1. Trial design

The data presented in the current report stem from a single-center randomized wait-list controlled trial (RCT) with three parallel groups. One hundred and four participants suffering from nightmare disorder were randomly allocated to one of three conditions: IR, IE, or WL. Patients in the two active treatment conditions received three weekly 60 min individual treatment sessions, and participants in the WL condition received one of the active treatments (by random assignment) after a 4-week waiting period. The data presented here concern the acute (i.e., pre- vs. post-assessment) outcomes of IR and IE therapy compared to WL, as well as their 3- and 6-months follow-up efficacy. The study was registered at the Netherlands Trial Register (NTR4951), and the Ethics Review Board of the University of Amsterdam (UvA) approved the research protocol (2014-CP-3794). For a detailed description of the trial design, see Kunze, Lancee, Morina, Kindt, and Arntz (2016).

2.2. Participants

Based on our hypothesis that both active treatments (i.e., IR and IE) should decrease nightmare symptoms from pre- to post-treatment assessment when compared to no treatment, a sample-size calculation (two-sided, power = 80%, alpha = 0.05; G*Power3.1) with a medium to large effect size for individual nightmare therapy ($d = 0.74$; Augedal et al., 2013) indicated that 30 participants per condition would suffice to detect statistically significant differences between each of the two treatment conditions and the WL condition (IR vs. WL and IE vs. WL) at post-assessment.¹ Based on this estimate, 104 adult patients with a principal DSM-5 diagnosis of idiopathic and/or posttraumatic nightmare disorder (APA, 2013) were included in the study. Inclusion criteria further involved: one or more nightmare(s) per week, recurrent (emotional) nightmare theme, and sufficient knowledge of the Dutch language. Exclusion criteria were: a current diagnosis of alcohol and/or drug abuse or dependency, PTSD resulting from protracted and recurring trauma (type 2 trauma), a current diagnosis of psychotic disorder, CBT-based psychotherapy for nightmare symptoms in the preceding 12 months, and instable medication intake. Other forms of comorbidity and medication intake were not a reason for exclusion. If applicable, participants were asked to keep their medication intake stable during and at least 4 weeks before treatment.

2.3. Procedure

Participants were recruited by means of online advertisements (i.e., Facebook, Twitter, public websites), and local newspaper announcements. Potential participants visited the information website where they received additional information about the trial. Interested participants filled out an online consent form and preliminary online screener, which assessed basic

¹ It bears mentioning that the present trial was not aimed at establishing superiority of or equivalence between IR and IE (see Kunze et al., 2016). It was therefore not sufficiently powered to detect differences between the two active treatments. However, given that a comparison of treatment vs. WL was not possible at follow-up due to the study design, potential differences between IR and IE concerning their long-term effects were explored. Note, however, that all exploratory analyses were likely to be underpowered.

inclusion and exclusion criteria. Eligible participants were then phoned for a short interview, which assessed nightmare symptoms, participant availability, possible medication intake, and possible differential diagnoses (e.g., pavor nocturnus). Qualified participants were invited for a face-to-face intake interview, where a baseline paper-and-pencil (pre-) assessment of all primary and secondary outcome measures took place. Written informed consent was obtained from all participants in twofold and a member of the research team carefully assessed each participant's eligibility against all in- and exclusion criteria. Participants not suitable for participation were contacted via phone or e-mail. Eligible participants were randomly assigned to one of the three conditions (i.e., IR, IE, or WL), and they were notified of the randomization outcome via e-mail or by phone. Participants assigned to IR or IE were informed that they were allocated to 'one of the treatment conditions', while the name and nature of the treatment was specifically not communicated to the participants. Note that due to the inherently different nature of the active treatments, therapists and patients were not blind for treatment condition. Participants in the WL condition received one of the two treatments after the assessment at the end of the waiting period following randomization. Note that the effects of the treatments in the WL condition were not processed in the current study.

One week after the pre-assessment, participants received the first of three weekly individual treatment sessions. In the beginning of each treatment session, participants were asked to fill out the primary treatment outcome measures. One week after the last treatment session (IR and IE) or after a 4-week waiting period following pre-assessment (WL), post-assessment took place for all participants, where all primary and secondary outcome measures were assessed. In order to ensure objective assessment of the treatment effect (i.e., DSM-5 nightmare disorder diagnosis), an independent assessor, who was blind to the participants' condition, conducted the assessment. If participants were not able to personally attend the post-assessment session, they were invited to fill out an online version of the primary and secondary outcome measures. In those cases, nightmare disorder diagnosis could not be assessed at post-assessment ($n = 9$).

Three and six months after treatment, participants were contacted via automated e-mails to complete the online follow-up questionnaires (Qualtrics, Provo, UT, USA). Participants who did not complete the online follow-up assessments within one week were contacted via automated reminder e-mails, personalized e-mails and/or phone calls.

All face-to-face assessments and therapy sessions took place at the outpatient psychotherapeutic clinic (PsyPoli) of the Department of Clinical Psychology at the UvA. If participants decided to discontinue treatment, efforts were made to retain the participants in the study, while respecting the participants' right to withdraw from participation at any time without any further consequences. Participants did not receive any monetary compensation for their involvement, but treatment was delivered free of charge.

2.4. Randomization

Treatment allocation progressed in accordance with an electronically generated allocation sequence (<https://www.sealedenvelope.com/simple-randomiser/v1/lists>), with randomized allocation block size (3, 6, and 9). Two independent staff members of the UvA stored a digital and a paper version of the allocation sequence and performed the randomization. The allocation sequence was concealed from all researchers, therapists, and participants.

2.5. Interventions

The IR and IE interventions were both written out in detailed treatment protocols that addressed the theoretical model, treatment frame, and use of the treatment techniques. Ten cognitive-behavioral therapists with a master's degree in clinical psychology delivered the interventions. At the beginning of the trial, their level of experience ranged from 0 to 11 years ($Mdn = 2.75$). All therapists delivered both interventions, however, balancing cases for each therapist across treatment type was not possible due to practical reasons. Therapists were trained by the authors during two 4-h training sessions (AK, JL, NM, and AA). The training involved assessment and diagnosis of nightmare disorder and a thorough explanation of the treatment protocols, including sample treatments and exercises. All therapists received weekly group supervision by the first and last author (AK and JL). In order to assess treatment fidelity, all treatment sessions were audio recorded. Two independent judges blind for treatment condition rated one randomly selected treatment session for each participant on treatment protocol adherence.

Both interventions consisted of three weekly individual 60 min sessions. Each treatment session consisted of filling out questionnaires (± 10 min), introducing and preparing the treatment exercises (± 5 min), 40 min imagery exercises (i.e., exposure to, or rescripting of, the nightmare content), and a short debriefing at the conclusion of each session (± 5 min). During the first treatment session, participants were presented with a brief standardized treatment rationale, which was kept to a minimum to avoid possible demand effects (see Kunze et al., 2016).

2.5.1. Imagery exercise

Each treatment session started with an imagery exercise. Here, participants were asked to briefly imagine their so-called core nightmare as vividly as possible. The core nightmare was identified during pre-assessment, and was defined as a nightmare that is highly emotional and part of the participants' recurring (emotional) nightmare theme (e.g., being killed, being followed, losing someone, etc.). In the present study, the core nightmare served two main purposes: First, due to a limited number of treatment sessions, treatment focused on the core nightmare only.² Second, identifying and treating one particular nightmare allows for the assessment of nightmare-specific treatment effects. For this purpose, fear of the imagery exercise, core nightmare frequency, nightmare vividness, subjective units of distress, tolerability of negative emotions elicited by the core nightmare (see Supplementary Material Table A for descriptives), and the strongest emotion experienced at the moment of core nightmare reactivation were measured during the imagery exercise. Note that the main goal of the imagery exercise was to *reactivate* the emotions sufficiently to address them in treatment, instead of prolonged exposure to these emotions. The core nightmare was therefore activated only briefly (4.5 min on average) and therapists were specifically instructed not to engage in prolonged exposure to the nightmare in such a way that the emotional responding would already decline. Immediately after core nightmare reactivation, treatment (IE or IR) started. In both conditions, patients were instructed to recall the core nightmare as if they would experience it in the present moment.

² In both therapies (IR and IE), treatment of other nightmares than the core nightmare was only allowed if treatment of the core nightmare caused a substantial decrease of subjectively reported nightmare distress early in the treatment process, and if the negative emotions accompanied by the core nightmare were completely tolerable. Whether or not a different nightmare than the core nightmare could be treated was always determined during supervision, and only occurred in rare cases.

2.5.2. Imagery rescripting

The IR protocol used in this study was based on traditional rescripting protocols (e.g., Arntz & Weertman, 1999) but diverged from the most widely used IRT methods (e.g., Krakow & Zadra, 2006, 2010) in several ways: First, treatment focused exclusively on rescripting exercises, while other treatment components such as psycho-education about nightmares, sleep, or mental imagery, as well as keeping nightmare diaries, and discussing nightmare content were discarded. Similar rescripting treatments have been shown to produce consistent effects on autobiographical aversive memories (see Morina, Lancee, & Arntz, 2017). With regard to the aim of the present study, we decided to use this more direct rescripting technique over the traditional IRT-based rescripting method, because it allows for the investigation of the imagery rescripting component of the treatment only, without any other possibly relevant treatment components involved (e.g., verbal reappraisal of the nightmare before the imagery rescripting, and safe-place or positive imagery exercises). Consequently, undesirable procedural and methodological differences between IR and IE were kept to a minimum. Moreover, applying IR immediately after following reactivation of the nightmare warranted the minimization of exposure elements in the IR condition. Second, in contrast to traditional IRT but in line with trauma-focused rescripting protocols (e.g., Arntz & Weertman, 1999), participants were asked to actively change the nightmare *in their imagination*. In order for the therapist to be able to follow the patients' mental images during IR, participants described the images out loud with as much detail as possible. For this purpose, participants were introduced to the rescripting technique in the beginning of the first treatment session. After reactivation of the core nightmare, participants were instructed to keep their eyes closed, and to change the nightmare in any way they wish, as long as it led to a satisfying story and/or fulfilled their emotional needs. Thus, instead of first discussing changes to the nightmare script with the therapist and subsequently rehearsing the new nightmare script (e.g., Krakow & Zadra, 2006, 2010), nightmares were rescripted directly after reactivation, while the accompanying emotions were still fully activated and accessible. It is important to emphasize the distinction between a short reactivation of emotions and prolonged exposure, where patients are exposed to an aversive event repeatedly and for a longer period of time (usually 45–60 min). Activation of emotional memories seems to be necessary for the adequate integration of corrective information to occur (Foa & Kozak, 1986). Concerning imagery rescripting, it has been proposed that the negative emotions accompanying an aversive event (e.g., nightmare) should be sufficiently reactivated before rescripting to increase the therapeutic success of the technique (Arntz, 2012; Dibbets & Arntz, 2016). Thus, we argue that reactivation of an aversive event within rescripting treatments should *not* be considered prolonged exposure, but it rather constitutes a requisite component of the rescripting technique. Third, contrary to traditional IRT, rehearsal of the new nightmare script did not take place outside the therapy sessions (i.e., no homework assignments). Instead, the new script was fine-tuned during the sessions in such a way that the negative emotions accompanying the nightmare are maximally reduced to the extent that the participant was satisfied with the new script and eventually felt at ease.

2.5.3. Imaginal exposure

The IE intervention used in the proposed study was similar to traditional IE interventions (Foa & Rothbaum, 1989). Such treatments usually consist of psychoeducation, exposure *in vivo*, imaginal exposure, and emotional processing (Rauch, Eftekhari, & Ruzek, 2012). The present protocol differed from these traditional prolonged exposure interventions in that it consisted of imaginal

exposure to the nightmare content only. Likewise, other treatment components usually implemented in exposure-based nightmare therapies such as nightmare diaries and relaxation exercises (e.g., Burgess et al., 1998; Lancee et al., 2010) were discarded. After reactivation of the core nightmare, participants were asked to keep their eyes closed and to vividly imagine the entire nightmare scenario in their imagination again, and to describe the images out loud as detailed as possible. During the exercise, the therapist encouraged the participant to focus on and experience all sensory details and emotions accompanying the imagined nightmare. If the imaginal representation of, or the emotions elicited by, the nightmares faded, the therapist tried to intensify the image and associated emotions by asking the participant to concentrate on the sensory details or the hotspot of the nightmare (i.e., the most gruesome part of the nightmare), or by letting patients express their bigger fear verbally (e.g., "He is going to kill me" or "I am all alone and no one will help me"). Alternatively, the nightmare script was rewound to the beginning, or to a more distressing part of the image. If necessary, possible (cognitive) avoidance tendencies were discussed to eliminate them in subsequent exercises.

2.6. Measures

Data on demographic variables (age, gender, and educational level) was collected for all participants. Diagnosis of nightmare disorder was assessed by means of a structured interview developed for the present study, based on DSM-5 criteria for nightmare disorder (APA, 2013). Current comorbid Axis-I disorders were assessed by means of several modules of the Dutch Structured Clinical Interview for DSM-IV-TR Axis I Disorders (SCID-I; van Groenestijn, Akkerhuis, Kupka, Schneider, & Nolen, 1999) at pre- and post-assessment (i.e., anxiety disorders and posttraumatic stress disorder, mood disorders, psychotic disorder, and substance abuse and dependency). Pre-treatment assessors were psychologists with a master's degree in clinical psychology. Amount of SCID-I training differed across assessors, according to their individual level of expertise. Due to the design of the study, the assessor conducting the pre-treatment measurement was always the participants' therapist, except for participants who were assigned to the WL condition. Importantly, all assessors were blind to condition during pre-assessment, given that treatment allocation took place only after successful inclusion of the participant.

2.6.1. Primary outcome measures

There were two primary outcome measures. *Nightmare frequency* was measured by means of the Nightmare Frequency Questionnaire (NFQ; Krakow et al., 2002). This questionnaire assesses 1) the number of nights with nightmares in the last week (nights with nightmares), and 2) the total number of nightmares in the last week (nightmare frequency) with two single questions. In this study, the latter constituted the first primary outcome measure, while number of nights with nightmares in the last week was considered a secondary outcome measure.

Nightmare distress was assessed with a 12-item instrument specifically constructed by AK and JL for the purpose of the present study. The nightmare distress and impact questionnaire (NDIQ) consists of two subscales, which discriminate between the distress caused by nightmares at night (e.g., "I am afraid to fall asleep, because I fear the nightmares I might have") and the impact caused by nightmares during the day (e.g., "Because of my nightmares, I cannot concentrate during the day"). Items of the NDIQ are scored on a four-point scale: 0 (Not), 1 (A little bit), 2 (Somewhat), and 3 (Completely). For reasons of parsimony, only the sumscore of both subscales was used as primary outcome measure in the present study. A high score on the NDIQ is indicative of severe nightmare

distress (range 0–36). The NDIQ proved to be a reliable measure in the current sample at pre-assessment (Cronbach's $\alpha = 0.75$; see also [Table B in the Supplementary Material](#) for Cronbach's α at all measurement points).

2.6.2. Secondary outcome measures

Insomnia complaints were assessed with the Dutch version of the Insomnia Severity Index (ISI; [Morin, 1993](#)). In line with the English version of the ISI, which has been shown to be valid and reliable measure to detect changes in insomnia severity (internal consistency = 0.78; [Bastien, Vallieres, & Morin, 2001](#)), an internal consistency of 0.77 (Cronbach's α) at pre-assessment was found in the present sample.

Dysfunctional beliefs about nightmares were measured with the newly developed Nightmare Beliefs Questionnaire (NBQ). AK and JL constructed the items of the NBQ, which were based on nightmare interviews with four pilot participants of the present study. Dysfunctional beliefs play an important role in sleep disorders (e.g., [Lancee et al., 2015](#)) and a range of other psychological disorders (e.g., [Boden et al., 2012](#); [Clark, 1986](#); [Smith et al., 2007](#)). We therefore constructed a measure that could assess dysfunctional beliefs specifically about nightmares. The NBQ is a 15-item self-report questionnaire that measures the degree to which individuals hold certain dysfunctional beliefs about nightmares (e.g., "I have nightmares, because something is wrong with my brain/head" or "I will never be able to get rid of my nightmares"). Items of the NBQ are scored on believability on a four-point scale: 0 (Not), 1 (A little bit), 2 (Somewhat), and 3 (Completely). Outcome values consist of the sum of all items, which can range from 0 (no dysfunctional beliefs about nightmares) to 45 (high levels of dysfunctional beliefs about nightmares). With a Cronbach's α of 0.71 at pre-assessment in the present sample, the NBQ disposes of an acceptable internal consistency.

Posttraumatic stress symptoms were assessed by means of the Zelf Inventarisatielijst [Self-Inventory List] (ZIL; [Hovens, Bramsen, & van der Ploeg, 2002](#)), a 22-item Dutch self-report inventory covering the severity of PTSD symptoms in the last four weeks. In contrast to other measures of PTSD symptoms, the ZIL assesses posttraumatic symptoms irrespective of the occurrence of a traumatic event. Given that posttraumatic as well as idiopathic nightmare sufferers were eligible for participation in the present study (but see section 3.1.), it was assumed that some participants would not have experienced a traumatic event. While other measures would have been more appropriate to assess symptom severity in a sample of PTSD sufferers, the ZIL seems to be a suitable measure of posttraumatic symptom severity in the present mixed sample. The reliability of the scale proved to be good in the current sample, with a Cronbach's α of 0.90.

2.6.3. Additional measures

If participants experienced one or more nightmares during the previous week, they were instructed to fill out the following four questions measured on visual analogue scales ranging from 0 to 100: "How intense were the emotions you experienced during the nightmare(s)?" (0 = not intense at all; 100 = very intense), "How vivid was/were the nightmare(s)?" (0 = not vivid at all; 100 = very vivid), "How often did you awake from nightmare(s)?" (0 = never; 100 = always), "How was your sleep quality during the past week?" (0 = very bad; 100 = very good). In addition, all participants were asked to indicate their average hours of sleep per night during the past week.

Treatment acceptability was measured by two additional items at 3-months follow-up assessment. Participants were asked to indicate how pleasant they perceived the treatment and how satisfied they were with the treatment they received on a scale

ranging from 0 (not at all pleasant/satisfied) to 10 (very pleasant/satisfied).

Therapist protocol adherence was measured using a self-made therapist protocol adherence scale developed for the present study. The scale consisted of four subscales, each assessing different aspects of the treatment protocol: the imagery exercise, general treatment variables with regard to the imaginative nature of the treatment, exposure-specific items and rescripting-specific items (see [Appendix A in the Supplementary Material](#)). All items were dichotomously scored on whether or not the therapist adhered to the protocol, with 0 indicating that the therapists did not follow the protocol and 1 indicating that the therapist did follow the protocol on each particular aspect of the treatment. The sum of all items for each subscale ranged from 0 to 3 for the imagery exercise subscale, 0–7 for the general treatment variables subscale, and 0–6 for the exposure-specific and rescripting-specific subscales, with high sum scores representing good protocol adherence.

It should be noted that additional measures concerning proposed process (or mechanism) variables for IR and IE were assessed during the study. However, due to the purpose of the present report, these variables will not be described or presented here, but see [Kunze et al. \(2016\)](#) for a detailed description of all measures.

2.7. Statistical methods

Data integrity checks included valid values and range checks. In line with previous studies (e.g., [Lancee et al., 2010](#)) nightmare frequency was log-transformed to meet the normality assumption. As planned (see [Kunze et al., 2016](#)), generalized mixed (multilevel) regression analyses were conducted to evaluate the within-group (Time) and between-group (Time \times Condition) effects of the interventions. For NDIQ, nights with nightmares, as well as NBQ and ZIL scores, mixed Negative Binomial regressions with a log link were used because of skewed distributions of the residuals. For all other outcomes, linear mixed regression with an identity link was used. All analyses were conducted on the sample of treatment initiators, meaning that all randomized participants who started treatment were included in the analyses, irrespective of whether or not they completed therapy or assessments. Participants who were randomized after intake but did not start treatment were defined as treatment refusers and were not included into the analysis (these participants might have already been informed about the outcome of the randomization (e.g., treatment or WL), but they did not yet receive any information concerning the nature or content of the therapy; see section 2.3.). Short-term (pre- vs. post-assessment) and long-term effects (post- vs. 3-months follow-up vs. 6-months follow-up assessment) were examined by modeling time effects using an unstructured covariance structure for the repeated-part of the model, as being the best fitting model for the data.

Pre-treatment differences on demographic and clinical variables between the three groups were explored. Decisions concerning the inclusion of meaningful covariates into the analysis were based on statistical significance and/or clinical importance. Chi-square analyses showed that educational level differed significantly across groups, and this difference was particularly meaningful with regard to low level education. Moreover, we observed non-significant but clinically relevant group differences on raw nightmare frequency scores during baseline. In order to control for these initial group differences, log-transformed nightmare frequency at pre-assessment and educational level were added to the regression models as covariates (i.e., fixed effects; main effects, no interactions), except for the analysis with nightmare frequency as outcome measure, where only educational level was added as covariate.

For all primary and secondary outcome measures, we first

compared the active treatment conditions to WL, in order to investigate the effect of treatment vs. no treatment from pre- to post-assessment. The basic model was a two-level (participants and measurement points) repeated-measures design with the outcomes as dependent variable (i.e., nightmare frequency, NDIQ, nights with nightmares, ISI, NBQ, ZIL), Treatment as between-subjects factor (active treatment vs. WL) and Time as within-subjects factor (pre- vs. post-assessment). The difference between active treatments and WL on outcome measures was represented by the Time \times Treatment interaction in the model. In case of significant Time \times Treatment interaction, we conducted an additional analysis for each outcome separately with Condition as two dummy coded (centered) between-subjects factors and Time as within-subjects factor. Here, we investigated the specific effects of the two interventions relative to WL, which were represented by Time \times Condition interactions in the model (Time \times IR vs. WL and Time \times IE vs. WL).

A piecewise multilevel regression was used to investigate the effects of both treatments (IR and IE) from post- to follow-up (FU) assessments. The basic model was a two-level (participants and measurement points) repeated-measures design with the outcomes as dependent variable (i.e., nightmare frequency, NDIQ, nights with nightmares, ISI, NBQ, ZIL), Condition (centered) as between-subjects factor (IR vs. IE) and Time as within-subjects factor (pre- vs. post- vs. 3-months FU vs. 6-months FU assessment). Based on theoretical assumptions, we defined two regression slopes in the model with post-assessment as breakpoint. Effects on the outcomes due to treatment were modeled by a pre- vs. post-assessment slope (Slope 1). In addition, we defined a post- vs. 3-months FU vs. 6-months FU slope (Slope 2), because we expected that treatment effects would be maintained after post-assessment. Thus, symptom changes across FU assessments were represented by the main effect for Slope 2, and any difference between treatments on the outcome measures was represented by a Slope 2 \times Condition interaction in the model.

Cohen's d (Cohen, 1988) was used as an effect size, and computed from the multilevel estimated means and observed standard deviations. Within-condition change was defined as $d = (M_{pre} - M_i) / SD_{pooled-pre}$, where $SD_{pooled-pre} = \sqrt{[(SD_{preIR}^2 + SD_{preIE}^2 + SD_{preWL}^2) / 3]}$. Between-group effect sizes were determined by calculating the difference between the within-condition effect size; $\Delta d = [(M_{pre1} - M_{i1}) - (M_{pre2} - M_{i2})] / SD_{pooled-pre}$ (Morris, 2008). Differences between IR/IE and WL at post-assessment were defined as $d = (M_{post1} - M_{post2}) / SD_{pooled-post}$, where $SD_{pooled-post} = \sqrt{[(SD_{post1}^2 + SD_{post2}^2) / 2]}$.

A logistic regression analysis was conducted to predict nightmare diagnosis at post-assessment using group (treatment vs. WL) as predictor, and educational level and log-transformed nightmare frequency at pre-assessment as covariates.

All effects were tested at the 0.05 α -level (two-tailed). Analyses were carried out in SPSS version 24. Results are reported in accordance with the CONSORT guidelines for reporting clinical trials (Moher et al., 2010).

3. Results

3.1. Sample

Participant flow is shown in Fig. 1. Recruitment took place from January 2015 to May 2016. Accordingly, the last 6-months follow-up assessment occurred in November 2016. In principle, the procedure from pre- to post-assessment spanned four weeks in total for all participants and 51% of the sample completed the procedure within this time window. Due to rescheduling of appointments, 34% of participants concluded the procedure within 5 weeks and

15% within max 8 weeks.

Demographic characteristics and nightmare relevant pre-treatment variables of the sample stratified according to condition are displayed in Table 1. Mean age of the final sample was 35.08 ($SD = 14.73$) years, and 83.3% of all participants were female. Participants reported to have had nightmares for 16.90 ($SD = 14.16$) years, 16.6% were diagnosed with a comorbid axis I disorder, and 28.1% took medication. Overall, the majority of participants were educated at the higher professional and/or university level (82.3%), but there was a significant difference between the groups on education. This difference was controlled for in all analyses. There were no other relevant differences between the three conditions for any of the demographic or other pre-treatment variables.

The majority of the sample consisted of idiopathic nightmare sufferers ($n = 83$), who reported that their nightmares were unrelated to any (traumatic) life event. Ten participants indicated that their nightmares were based on aversive life events, which do not comply with the DSM-IV definition of trauma (e.g., end of a relationship, death of a significant other due to illness, or mobbing at the workplace). Three participants stated that (at least some of) their nightmares were based on a traumatic event as demarcated by the DSM-IV, but these participants did not meet conditions to receive a PTSD diagnosis.

3.2. Therapist protocol adherence

For each participant in the IE and IR condition, one randomly selected treatment session was assessed for therapist adherence to the treatment protocol. Six audio recordings were missing either due to technical failure or because the participant did not give permission to record the treatment sessions. A total of 55 audio recordings (28 and 27 in the IE and IR condition, respectively) were judged by two independent raters. High intraclass correlations demonstrated strong absolute agreement between the two raters for all four subscales (0.89 - 0.99). Several independent samples t -tests on the average rating across raters further indicated high overall treatment fidelity (i.e., therapists did not use rescripting techniques in the exposure group and vice versa), as indicated by significant differences between the IR and IE treatment on the rescripting and the exposure subscale (see Table C in the Supplementary Material).

3.3. Treatment retention and acceptability

Treatment dropout was approximately equally distributed across the active treatment conditions ($n = 2$ for IR and IE). In the IR group, one participant dropped out after the first treatment session due to physical health issues. The second dropout in the IR condition was not able or willing to adhere to the treatment protocol and decided to terminate treatment after the second treatment session. In the IE group, one participant reported physical health problems and dropped out of treatment after the first session. The second dropout in the IE condition discontinued treatment after the first session due to the experienced discomfort during treatment. No dropout occurred in the WL condition.

With regard to treatment acceptability, univariate ANOVAs indicated that IR ($M = 5.00$, $SD = 1.36$) was perceived as significantly more pleasant than IE ($M = 3.45$, $SD = 1.66$), $F(1, 47) = 12.90$, $p = 0.001$. Interestingly, no difference on treatment satisfaction could be observed between the groups, $F(1, 47) = 0.10$, $p = 0.748$ ($M_{IR} = 5.26$, $SD_{IR} = 1.77$; $M_{IE} = 5.41$, $SD_{IE} = 1.40$).

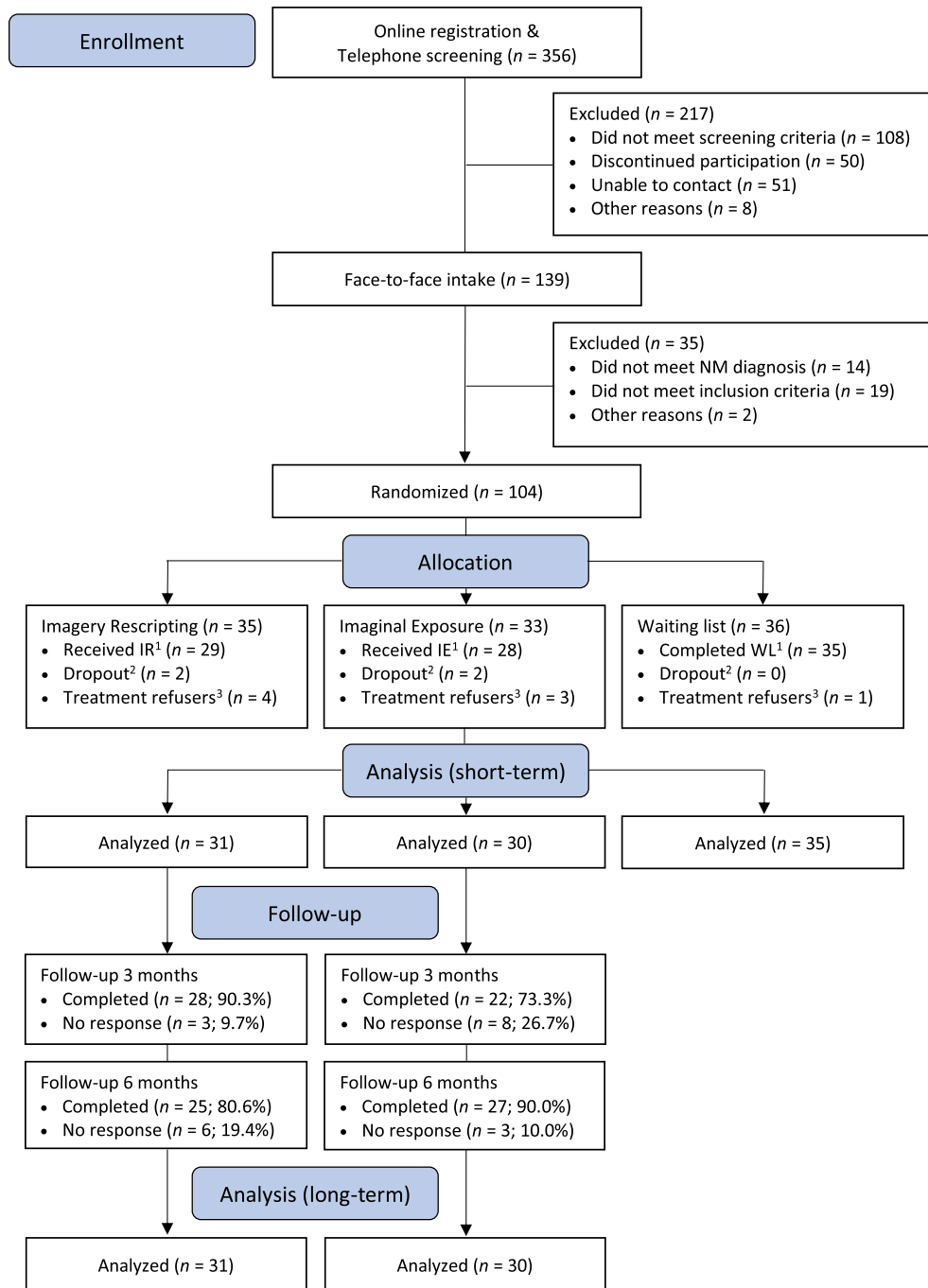


Fig. 1. Flow of participants.

¹Participants who received IR/IE or completed WL and whose post-assessment data are available. ²Dropout = Participants who decided to discontinue study participation after at least one session. ³Treatment refusers = Participants who might have already been informed about the outcome of the randomization (e.g., treatment or WL), but who had not yet received any information concerning the nature or content of the therapy.

3.4. Treatment outcomes

3.4.1. Primary outcomes

Multilevel regression analyses revealed significant Treatment \times Time interactions for nightmare frequency, $F(1, 182) = 9.82, p = 0.002$, and nightmare distress, $F(1, 179) = 14.18, p < 0.001$, indicating that the active treatments differed from WL on both primary outcome measures over time. More specifically, analyses showed that when compared to WL, nightmare frequency was significantly reduced in the IE group, $F(1, 180) = 6.58, p = 0.011$,

and in the IR group, $F(1, 180) = 7.45, p = 0.007$ (Fig. 2A). Similarly, nightmare distress decreased significantly from pre- to post-assessment in both the IE, $F(1, 177) = 13.06, p < 0.001$, and the IR group, $F(1, 177) = 7.61, p = 0.006$, when compared to WL (Fig. 2B; see Table 2 for corresponding estimated means and within- and between-group effect sizes). Inspection of the effect sizes indicated that the effects of IR and IE on nightmare frequency were similar in magnitude ($\Delta d_{IR-WL} = 0.74$; $\Delta d_{IE-WL} = 0.70$). Concerning nightmare distress, IE ($\Delta d_{IE-WL} = 1.35$) seemingly produced larger effects than IR ($\Delta d_{IR-WL} = 0.98$). However, given that the study was not powered

Table 1
Demographic variables and pre-treatment characteristics of the sample.

	Group			Test statistic
	IR (n = 31)	IE (n = 30)	WL (n = 35)	
Age in years, <i>M</i> (<i>SD</i>)	35.00 (16.62)	33.40 (12.98)	36.60 (14.62)	$F_{(2, 93)} = 0.38, p = 0.687$
Female sex, <i>n</i> (%)	26 (83.9)	25 (83.3)	29 (82.9)	$\chi^2 = 0.01, p = 0.994$
Education, <i>n</i> (%)				$\chi^2 = 11.19, p = 0.025$
Low	6 (19.4)	1 (3.3)	0 (0)	
Medium	4 (12.9)	2 (6.7)	4 (11.4)	
High	21 (67.7)	27 (90.0)	31 (88.6)	
Comorbidity, <i>n</i> (%)				$\chi^2 = 1.78, p = 0.776$
Any anxiety disorder	5 (16.1)	2 (6.7)	6 (17.1)	
Any mood disorder	1 (3.2)	1 (3.3)	1 (2.9)	
Medication intake, <i>n</i> (%)				$\chi^2 = 8.19, p = 0.225$
Psychotropic medication	5 (16.1)	6 (20.0)	7 (20.0)	
Medication for somatic problems	7 (22.6)	2 (6.7)	1 (2.9)	
Duration of NMs in years, <i>M</i> (<i>SD</i>)	17.44 (15.28)	15.00 (11.79)	18.06 (15.19)	$F_{(2, 93)} = 0.40, p = 0.669$
Hours of sleep per night, <i>M</i> (<i>SD</i>)	6.90 (1.47)	6.98 (1.12) ^a	6.86 (0.91)	$F_{(2, 92)} = 0.09, p = 0.913$
Quality of sleep, <i>M</i> (<i>SD</i>)	42.90 (21.67) ^b	38.33 (23.51)	36.51 (20.01)	$F_{(2, 92)} = 0.73, p = 0.486$
NM vividness, <i>M</i> (<i>SD</i>)	84.79 (11.95) ^c	75.77 (18.48)	82.49 (14.15)	$F_{(2, 91)} = 2.89, p = 0.061$
Awakening from NMs, <i>M</i> (<i>SD</i>)	72.93 (22.18) ^d	60.13 (30.81)	63.66 (25.68)	$F_{(2, 90)} = 1.80, p = 0.172$
Intensity of emotions during NMs, <i>M</i> (<i>SD</i>)	66.93 (22.43) ^e	73.27 (16.82)	66.46 (20.30)	$F_{(2, 91)} = 1.12, p = 0.331$

Note. IE = Imaginal Exposure; IR = Imagery Rescripting; NM = Nightmare; WL = Wait-list; Quality of sleep, NM vividness, awakening from nightmares, and intensity of emotions during NMs were measured on visual analog scales ranging from 0 to 100 (see also 'other measures').

^an = 29, ^bn = 30, ^cn = 29, ^dn = 28, ^en = 29.

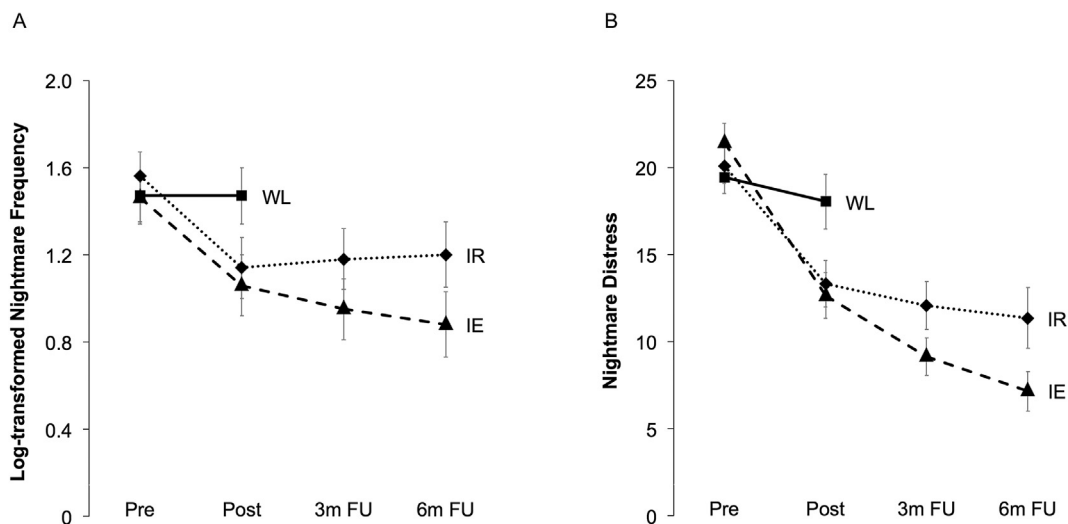


Fig. 2. Graphical representation of the treatment effects on (A) nightmare frequency and (B) nightmare distress based on mixed regression estimates. FU = Follow-up; IE = Imaginal Exposure; IR = Imagery Rescripting; WL = Wait-list; Error bars represent SEM.

to detect statistically significant differences between the treatments, no conclusions about the superiority of IR or IE can be drawn from the present data. Post-treatment effects on nightmare frequency were sustained over the course of FU assessments, as indicated by a non-significant main effect for Slope 2, $F(1, 212) = 0.38, p = 0.541$. Nightmare distress further decreased at FU assessment, as shown by a significant main effect for Slope 2, $F(1, 207) = 8.67, p = 0.004$. For an overview of the multilevel regression results, see [Table D and E in the Supplementary Material](#). Observed means and standard deviations of all outcome measures are depicted in [Table F in the Supplementary Material](#).

3.4.2. Secondary outcomes

Analyses yielded significant Treatment \times Time interactions for nights with nightmares, $F(1, 180) = 5.21, p = 0.024$, nightmare beliefs, $F(1, 174) = 12.89, p < 0.001$, insomnia complaints, $F(1,$

$175) = 14.01, p < 0.001$, and posttraumatic symptoms, $F(1, 177) = 5.83, p = 0.017$, indicating that the active treatments differed from WL over time on all secondary outcome measures. Compared to WL, IR significantly reduced nights with nightmares, $F(1, 178) = 3.92, p = 0.049$, nightmare beliefs, $F(1, 172) = 7.52, p = 0.007$, insomnia complaints, $F(1, 173) = 7.75, p = 0.006$, and posttraumatic symptoms, $F(1, 175) = 6.10, p = 0.015$. Similar results were found for IE, which significantly decreased nightmare beliefs, $F(1, 172) = 10.79, p = 0.001$, and insomnia complaints, $F(1, 173) = 13.09, p < 0.001$, when compared to WL. Marginally significant Time \times IE vs. WL interactions were observed for nights with nightmares, $F(1, 178) = 3.13, p = 0.078$, and posttraumatic symptoms, $F(1, 175) = 2.58, p = 0.110$. Several non-significant main effects for Slope 2 indicated that the initial effects of IR and IE at post-assessment remained stable over the course of the FU-assessment for nights with nightmares, $F(1, 208) = 1.01, p = 0.316$, nightmare beliefs, $F(1,$

Table 2 Corrected mixed-regression based estimated means and standard errors (in parentheses), and within- and between-group effect sizes (Cohen's *d*) with 95% confidence intervals (in brackets).

Group	Pre-assessment		Post-assessment		$\Delta d_{\text{between}}$	d_{post}	3-months FU		6-months FU	
	<i>M</i> (<i>SE</i>)	<i>d</i> _{within}	<i>M</i> (<i>SE</i>)	<i>d</i> _{within}			<i>M</i> (<i>SE</i>)	<i>d</i> _{within}	<i>M</i> (<i>SE</i>)	<i>d</i> _{within}
Log-transformed Nightmare frequency	IR	1.56 (0.11)	0.74 [0.21, 1.26]	1.14 (0.14)	0.74 [0.24, 1.24]	0.44 [-0.05, 0.95]	0.67 [0.14, 1.19]	1.18 (0.14)	0.63 [0.09, 1.17]	
	IE	1.46 (0.11)	0.70 [0.17, 1.24]	1.06 (0.14)	0.70 [0.20, 1.21]	0.61 [0.11, 1.13]	0.89 [0.31, 1.48]	0.95 (0.14)	0.88 (0.15)	
	WL	1.47 (0.10)	0.00 [-0.47, 0.47]	1.47 (0.13)						
NDIQ	IR	20.09 (1.02)	1.23 [0.68, 1.78]	13.32 (1.33)	0.98 [0.47, 1.49]	0.64 [0.14, 1.16]	1.46 [0.88, 2.04]	12.07 (1.37)	1.59 [0.99, 2.19]	
	IE	21.42 (1.09)	1.60 [1.01, 2.19]	12.64 (1.31)	1.35 [0.81, 1.89]	0.76 [0.24, 1.28]	2.23 [1.54, 2.93]	9.14 (1.09)	2.59 [1.89, 3.30]	
	WL	19.41 (0.91)	0.25 [-0.23, 0.72]	18.04 (1.58)						
Nights with nightmares	IR	2.95 (0.17)	0.51 [-0.01, 1.02]	2.10 (0.25)	0.44 [-0.05, 0.93]	0.50 [0.00, 1.00]	0.44 [-0.07, 0.96]	2.21 (0.27)	0.44 [-0.10, 0.97]	
	IE	2.77 (0.17)	0.47 [-0.06, 0.99]	1.99 (0.27)	0.40 [-0.09, 0.89]	0.61 [0.10, 1.12]	0.61 [0.04, 1.17]	1.76 (0.27)	0.71 [0.17, 1.24]	
	WL	3.17 (0.17)	0.07 [-0.40, 0.54]	3.06 (0.29)						
NBQ	IR	13.62 (1.02)	0.75 [0.22, 1.27]	9.36 (1.06)	0.63 [0.12, 1.15]	0.76 [0.24, 1.27]	0.84 [0.30, 1.38]	8.83 (1.10)	0.77 [0.22, 1.32]	
	IE	14.19 (1.06)	0.90 [0.36, 1.44]	9.06 (1.06)	0.78 [0.26, 1.30]	0.75 [0.24, 1.27]	1.13 [0.53, 1.72]	7.77 (1.02)	1.17 [0.61, 1.74]	
	WL	14.52 (1.03)	0.12 [-0.37, 0.60]	13.86 (1.36)						
ISI	IR	14.93 (0.90)	0.77 [0.24, 1.30]	11.08 (0.94)	0.70 [0.19, 1.20]	0.58 [0.07, 1.10]	0.76 [0.23, 1.30]	11.12 (0.90)	0.76 [0.22, 1.31]	
	IE	14.99 (0.91)	0.99 [0.44, 1.53]	10.04 (0.90)	0.92 [0.40, 1.44]	0.79 [0.27, 1.32]	1.24 [0.64, 1.84]	8.79 (0.93)	1.39 [0.81, 1.98]	
	WL	14.38 (0.85)	0.07 [-0.41, 0.56]	14.02 (0.85)						
ZIL	IR	44.54 (2.01)	0.67 [0.17, 1.17]	37.32 (1.72)	0.46 [-0.03, 0.96]	0.10 [-0.39, 0.61]	0.67 [0.14, 1.20]	37.30 (1.55)	0.75 [0.20, 1.29]	
	IE	41.44 (1.94)	0.49 [-0.30, 1.02]	36.13 (1.70)	0.28 [-0.21, 0.78]	0.24 [-0.26, 0.75]	0.68 [0.12, 1.25]	34.07 (1.52)	0.81 [0.26, 1.36]	
	WL	40.54 (1.76)	0.21 [-0.27, 0.68]	38.30 (1.59)						

Note. NDIQ = Nightmare Distress and Impact Questionnaire; NBQ = Nightmare Beliefs Questionnaire; ISI = Insomnia Severity Index; ZIL = Self-inventarisation lijst [Self-inventory list]; IE = Imaginal exposure; IR = Imagery rescripting; WL = Wait-list; FU = follow-up assessment; $d_{\text{within}} = (M_{\text{pre}} - M_{\text{post}}) / SD_{\text{pooled-pre}}$; $\Delta d_{\text{between}} = [(M_{\text{pre}} - M_{\text{post}}) - (M_{\text{preWL}} - M_{\text{postWL}})] / SD_{\text{pooled-pre}}$; $d_{\text{post}} = (M_{\text{postWL}} - M_{\text{postIR}}) / SD_{\text{pooled-post}}$; *M*s for effect size calculations were based on mixed-regression based estimated means; *SE*s for effect size calculations were based on the observed values (see [Supplementary Material Table F](#)).

205) = 0.01, $p = 0.931$, and insomnia complaints, $F(1, 205) = 1.28$, $p = 0.259$. Posttraumatic symptoms further decreased over the course of FU assessments, as shown by a significant main effect for Slope 2, $F(1, 205) = 5.79$, $p = 0.017$. Exploratory analyses did not yield any differences between the treatment groups for any of the variables.

3.5. Clinical improvement

A test of the full logistic regression model against the constant only model was statistically significant, $X^2(4) = 12.27$, $p = 0.015$, indicating that receiving treatment or not predicted whether participants would meet criteria for a nightmare disorder diagnosis at post-assessment. Inspection of the data revealed that 12.9% of participants in the WL group did not meet criteria for nightmare disorder at post-assessment. In the treatment conditions, this percentage was considerably larger with 42.9% of all participants in the IE group and 37% of participants in the IR group.

3.6. Adverse events

There were no adverse events related to the interventions or the trial.

4. Discussion

In the present study, we investigated the efficacy of imagery rescripting (IR) and imaginal exposure (IE) for nightmares compared to a wait-list (WL) control condition. Using stripped-down treatment protocols, which consisted of either IR or IE, we specifically intended to examine the therapeutic success of the two treatment components separately. Though initially not anticipated, the sample predominantly consisted of idiopathic nightmare sufferers. In line with the hypotheses, IR and IE both effectively reduced nightmare frequency and distress when compared to WL, as well as other associated nightmare symptoms such as nights with nightmares, insomnia complaints, and dysfunctional nightmare beliefs. Initial effects at post-treatment were maintained at 3- and 6-months follow-up assessments.

With this study, we examined the exclusive working of IR and IE, without the influence of any other treatment components. By doing so, this study adds preliminary empirical support for IR and IE as efficacious elements of nightmare treatments and lays the groundwork for future research aimed at identifying the principal treatment components of nightmare therapies. With regard to nightmare frequency, we observed moderate to large pre-post effect sizes of IR and IE compared to WL ($d = 0.74$ and 0.70 , respectively), as well as moderate post-treatment effect sizes ($d = 0.44$ and 0.61 , respectively). Our results are in line with those observed in recent meta-analyses, which reported medium pre-post effect sizes (Hedge's $g = 0.55$; [Hansen et al., 2013](#)) and post-treatment effect sizes (Cohen's $d = 0.46$; [Augedal et al., 2013](#)) for psychological nightmare treatments including rescripting- and exposure-based techniques. Concerning nightmare distress, we observed large pre-post effect sizes for IR and IE compared to WL ($d = 0.98$ and 1.35 , respectively), and post-treatment effect sizes ($d = 0.64$ and 0.76 for IR and IE, respectively) were at least comparable to those reported in earlier studies ($d = 0.39$; [Augedal et al., 2013](#)). These results are remarkable given the fact that the present study did not aim to design the most efficacious treatment for nightmare disorder, but rather to investigate the efficacy of isolated treatment components.

Interestingly, a recent study by [Pruksma et al. \(2016\)](#), showed that ERRT with and without rescripting and exposure both significantly improved nightmare symptomatology in trauma-

related nightmares. However, the full protocol including exposure and rescripting was statistically not superior to the protocol without exposure and rescripting, which consisted of relaxation training, sleep habit modification, and psychoeducation about trauma, nightmares, and sleep only. Similarly, it has been shown that keeping a nightmare diary alone produced significant symptom change in self-help format, when compared to a wait-list control group (Lancee et al., 2010). Thus, even though the present study showed that IR and IE were both superior to a WL control condition, it is yet to be determined whether the proposed active treatment components (i.e., rescripting and exposure) are indispensable to produce significant therapeutic change in nightmare sufferers. Well-powered studies are needed in order to establish superiority or equivalence of IR and IE (or a combination) in nightmare treatments among both idiopathic and posttraumatic nightmare sufferers, and to investigate whether other treatment components may improve the IR/IE modules. In a similar vein, future studies should determine if a combination of IR and IE (such as employed in the ERRT format) is superior to IR or IE alone.

A few limitations should be considered when interpreting the findings of this study. First, while both posttraumatic and idiopathic nightmare sufferers were eligible for participation in the present study, the sample mainly consisted of participants suffering from idiopathic nightmares. Though the distinction between idiopathic and posttraumatic nightmares has not yet been robustly established (Hasler & Germain, 2009), posttraumatic nightmares usually refer to nightmares related to a specific traumatic event, either during the acute stress response or over the course of PTSD. In contrast, idiopathic nightmares are typically unrelated to a traumatic event or PTSD (Germain & Nielsen, 2003). In the present study, only 3 participants reported nightmares based on a traumatic event as demarcated by the DSM-IV, while none of them received a current PTSD diagnosis. In addition, ten participants indicated that the content of their nightmares was related to other aversive life events, such as separation from a partner or the death of a significant other. Although such events can elicit high levels of suffering and distress, they do not comply with the DSM-IV (or DSM-5) definition of trauma. With regard to current definitions of posttraumatic nightmares, it therefore remains equivocal whether nightmares based on such events can be classified as posttraumatic. Correspondingly, it is unclear whether IR and IE as used in the present study can achieve similar results among patients suffering from explicit posttraumatic nightmares. While idiopathic and posttraumatic nightmares seem to have fundamentally different origins (Schredl, 2008), little is known about the similarities and differences between these types of nightmares, and more research is needed to understand their underlying (physiological) etiology and maintenance factors (Germain & Nielsen, 2003). Given that the avoidance of trauma reminders plays an important role in the maintenance of PTSD, it has been proposed that treatment of trauma-related nightmares should rely on treatment techniques specifically aimed at the reduction of avoidance, such as exposure techniques (Davis & Wright, 2005). However, this proposition is lacking empirical evidence and it is currently unclear whether both types of nightmares can be treated equally well with similar techniques (Aurora et al., 2010), or whether treatment focus should differ for various types of nightmares. Based on the present data, we propose that idiopathic nightmares are responsive to rescripting-as well as exposure-based treatments.

Second, the fact that a fairly small number of participants in our sample were diagnosed with comorbid anxiety and/or mood disorders may limit the generalizability of the current results. Nightmare disorder prevalence is considerably higher in psychiatric samples compared to non-psychiatric samples (Swart et al., 2013), and effect sizes of nightmare treatments tend to be smaller in

studies which included patients with various psychiatric diagnoses (e.g., van Schagen, Lancee, de Groot, Spoormaker, & van den Bout, 2015), compared to those which included more homogeneous samples (e.g., Krakow et al., 2001).

Third, during each treatment session, IR and IE were both preceded by a short imagery exercise aimed at retrieving and activating the nightmare memory. While the primary purpose of this memory reactivation was to access relevant emotions that could subsequently be addressed in treatment, it may have also triggered the destabilization of the consolidated nightmare memory. If memory reactivation triggers the process of memory reconsolidation (e.g., Finnie & Nader, 2012; Pedreira, Pérez-Cuesta, & Maldonado, 2004; Sevenster, Beckers, & Kindt, 2013), the previously consolidated memory may be susceptible to interventions that interfere with the restabilization of the memory engram. This can lead to long-lasting attenuation of emotional reactions associated with the fear memory (Beckers & Kindt, 2017; Elsej & Kindt, 2017). In addition to pharmacological agents, such memory updating processes have been shown to be stimulated by behavioral interventions (Golkar, Tjaden, & Kindt, 2017; James et al., 2015; Monfils, Cowansage, Kiriana, Klann, & LeDoux, 2009; Schiller et al., 2010; but see Kindt & Soeter, 2013; Soeter & Kindt, 2011). These studies showed that extinction training (an analogue model for exposure treatment), a working memory task, or observational learning produced an abiding attenuation of emotional responses, when conducted within the time window of memory reconsolidation. In light of these findings, it could be argued that the imagery exercise used in the present study may have induced reconsolidation and thus rendered the nightmare memory susceptible for the integration of corrective information offered by IR and IE. While we certainly do not dismiss this hypothesis, it bears mentioning that mixed results regarding the effects of behavioral memory updating strongly suggest that the boundary conditions of the phenomenon are not yet uncovered (see Beckers & Kindt, 2017) and that additional research is needed to investigate this matter.

Fourth, even though we excluded nonspecific nightmare treatment components from the therapies (e.g., psycho-education, relaxation exercises, nightmare diary, etc.), we did not control for other nonspecific variables such as therapist contact. For it has been shown that comparisons of treatment versus passive control groups yield slightly more (yet not statistically significant) favorable results compared to those with active control groups in nightmare studies (Augedal et al., 2013), our effects might be somewhat inflated.

Fifth, we recognize that a lack of validation may reduce the confidence in the NDIQ as a primary outcome measure. However, given that the construction of the questionnaire was essentially based on items of two validated nightmare distress questionnaires (i.e., Nightmare Distress Questionnaire (Belicki, 1992) and Nightmare Effects Survey (Krakow et al., 2001)), the NDIQ has high face validity and we presume that it is a valid measure (Kunze et al., 2016). To test this supposition, validation of the NDIQ as well as the NBQ is currently ongoing.

Finally, we did not adjust our power calculations for multiple testing, and we therefore did not apply any corrections to the data. However, if Bonferroni correction for multiple testing were applied for the analyses of pre- vs. post-assessment outcomes (i.e., alpha divided by three for each outcome), all effects except those on nights with nightmares (IR and IE) and posttraumatic symptoms (IE) would have survived significance testing.

To conclude, we found stripped-down IR and IE to be effective in the treatment of nightmares and the effects seem similar in magnitude when compared to the complete protocols (e.g., Krakow & Zadra, 2010). While these results are remarkable for a short 3-session intervention, it should be noted that approximately 60%

of participants who underwent treatment still met criteria for nightmare disorder at post-assessment. We thus argue that treatment development and refinement is necessary to further improve treatment efficacy. Possible variables of interest may include the therapeutic effects (Augedal et al., 2013; Pruiksma et al., 2016) and working mechanisms (Hansen et al., 2013; Kunze et al., 2016) of different nightmare treatment components, treatment intensity (e.g., duration and number of sessions), and individual differences between nightmare sufferers such as the type of nightmares (i.e., idiopathic or posttraumatic). In other words, to ultimately design the most effective treatment protocol for nightmares, we need to find out *what works* (for *whom*), and *how* it works.

Authors' contributions

AK, JL, NM, MK, and AA contributed to the design of the study. AK and JL are the principal investigators and carried out participant recruitment and data-collection. AK, JL, NM, and AA wrote the treatment manual for the used interventions. AK drafted the manuscript. All authors contributed to the writing of the manuscript and approved the final manuscript.

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Conflict of interest

The authors declare that they have no conflict of interest.

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Supplementary material

Supplementary material related to this article can be found at <http://dx.doi.org/10.1016/j.brat.2017.06.005>.

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