



# Imagery Rescripting of Autobiographical Memories Versus Intrusive Images in Individuals with Disordered Eating

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## Abstract

**Background** This study compared the effect of imagery rescripting (ImRs) of early autobiographical memories to ImRs of intrusive images and a no task control condition on eating disorder (ED) related core beliefs and ED symptoms in individuals at risk of developing an eating disorder. We qualitatively explored the content of ImRs scripts.

**Method** Participants ( $N=66$ , 87.8% females) were allocated to one of three conditions: ImRs of autobiographical memories, ImRs of intrusive images, or a no task control condition. Participants in the ImRs conditions received a 9-min self-guided ImRs intervention in the lab and practiced ImRs daily for the next 6 days online. Participants in the no task control condition took a 9-min break and did not do any further tasks. All participants attended a follow-up testing 1 week after the lab session.

**Results** Both ImRs manipulations resulted in greater reductions in negative core beliefs and ED symptoms compared to the no task control group. However, there were no differences among the two ImRs groups. The most widely used rescripting strategy was self-compassion, followed by unhealthy, ED-confirming strategies. No significant associations were found between the ImRs strategies and any of the outcome measures.

**Conclusion** ImRs may be a promising intervention for individuals with disordered eating and both early memories as well as intrusive images may be useful targets.

**Keywords** Eating disorders · Imagery rescripting · Autobiographical memories · Intrusive images

## Introduction

An eating disorder (ED) can cause serious impairments in physical health and psychosocial functioning (Grave, 2011). Current treatment outcomes for EDs are not optimal, as witnessed by high relapse rates (Hay, 2013), or lack of progress with any treatment (Grave, 2020). This signals the need for improvement of the available treatments, for novel interventions, and for a better understanding of mechanisms of change of ED interventions (Jansen, 2016).

The transdiagnostic cognitive model of EDs highlights the core beliefs that over-evaluate body shape, weight, and their control (Fairburn, 2008). Core beliefs are unconditional and rigid beliefs about oneself (e.g., I am unlovable), others, and the world (Beck, 1967), and are part of a relatively stable cognitive structures referred to as ‘schemas’. Maladaptive schemas are defined as pervasive self-defeating mental representations or character traits, which have a powerful impact on sensations, emotions, and behavior (Young, 1990, 1994). Maladaptive schemas are proposed to be formed as a result of adverse early experiences where core basic needs (e.g., safety or autonomy) were not adequately fulfilled (Arntz et al., 2021; Young, 1990).

Evidence is accumulating that intrusive images are a prominent feature in EDs and may play a role in their maintenance (Dugué et al., 2016; Kadriu et al., 2019; Somerville et al., 2007). Intrusive images are thought to derive from adverse or traumatic autobiographical memories, and thereby reflect core beliefs that have been developed through these experiences (Conway & Pleydell-Pearce, 2000; Conway et al., 2004; Cooper et al., 1998; Hackmann

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et al., 1998). Two studies in patients with bulimia nervosa have demonstrated associations between intrusive images and early adverse memories (Somerville et al., 2007), and between intrusive images and dysfunctional core beliefs (Somerville & Cooper, 2007). Hinrichsen et al. (2007) further reported that most patients with bulimia nervosa experienced thoughts that reflected negative core beliefs and distressing mental images prior to self-induced vomiting. Further, patients linked these mental images to adverse life experiences.

Although intrusive images can represent memories, that is not always the case (Krans et al., 2015). Intrusive images can additionally represent, e.g., current (negative) self-images, hypothetical reconstructions, flash forwards, and images of feared outcomes (Çili & Stopa, 2021; Kadriu et al., 2019; Krans et al., 2015). No study so far has compared the number of intrusive images that represent memories and non-memories in patients with eating disorders. However, there are studies that have described the content of intrusive images in these patients categorized in themes (e.g., Kadriu et al., 2019; Somerville et al., 2007). Both of these studies found that patients with an ED typically experience intrusive images that relate to body distortions (images of their body looking distorted in weight or shape), negative self-images (e.g., she is looking at herself in the mirror, she hates herself), or negative social evaluation (e.g., ‘everyone laughs at me since I look fat’). Thus, intrusive images do not necessarily contain content that corresponds fully to an earlier memory. However intrusive images may still be associated conceptually with memories that share the same meaning or emotional tone (Çili & Stopa, 2021). For example, someone with intrusive images of themselves looking “fat”, may emotionally associate this image with the memory of being rejected by a potential partner because of their weight. Both mental representations may have the same meaning, e.g., feeling unattractive.

The use of experiential techniques, such as imagery rescripting (ImRs), may offer a viable addition to the current guideline treatment for EDs, i.e., Cognitive Behavioral Therapy-Enhanced (CBT-E; Fairburn, 2008), as ImRs directly targets memories and images linked to problematic core beliefs (Arntz, 2011, 2020). ImRs is commonly used in schema therapy, and it aims to alter encapsulated core beliefs by changing distressing memories or images using mental imagery (Holmes et al., 2007). It involves activating an early memory or image associated with the current psychological problem and imagining a more helpful course of events. This way, the individual can address their unmet needs (Arntz & Weertman, 1999). It has been proposed that ImRs enables the modification of core beliefs by mentally imagining, and thereby experiencing a corrective experience, which reduces the associated emotional response (Arntz, 2012). Thus, ImRs is thought

to have a different working mechanism from typical CBT techniques, by changing the meaning of the memory representation more directly through an experiential, rather than a cognitive or behavioural pathway (Arntz, 2012).

ImRs is showing promising results for a wide range of mental disorders, including in bulimia nervosa (for an overview see, Arntz, 2012, and Morina et al., 2017). In two pilot studies in bulimia nervosa, an ImRs session targeting traumatic memories decreased negative core beliefs (Cooper et al., 2007), although its effect did not significantly differ from cognitive restructuring (Dugué et al., 2018). Two studies in women with ED symptoms reported that a 5-min self-guided ImRs task delivered online for 1 week was associated with reduced disordered eating compared to a no-task control condition (Pennesi & Wade, 2018; Zhou et al., 2020). These studies indicate that ImRs has potential as a brief, easily accessible intervention for at-risk populations. However, effect sizes for the change in core beliefs were small ( $g = 0.2$ ; Cooper et al., 2007), and medium for disordered eating ( $d = 0.59–0.64$ ; Pennesi & Wade, 2018; Zhou et al., 2020). Furthermore, a recent randomized control trial in patients with anorexia nervosa showed that receiving one ImRs session before the treatment compared to treatment only actually slowed down symptom reduction (Zhou & Wade, 2021). Thus, research into the underlying mechanisms of ImRs is needed to optimize the technique for individuals with ED symptoms.

It has also been hypothesized that ImRs is most effective when targeting early aversive memories, as early aversive memories are assumed to lie at the core of dysfunctional schemas (Arntz, 2020). However, as mentioned earlier, intrusive images are also assumed to reflect these core beliefs, even when the image does not literally represent a specific memory (Hackmann & Holmes, 2004; Krans et al., 2009). It is therefore possible that ImRs of intrusive images is effective as well. This would support the theoretical notion that intrusive images are highly meaningful in psychopathology (Krans et al., 2009) and EDs (Kadriu et al., 2019). Furthermore, intrusive images are highly accessible and may therefore be easier to identify in treatment than early memories.

The first objective of this study was to experimentally test the effect of ImRs of early autobiographical memories versus intrusive images on ED symptoms (primary outcome) and ED-related core beliefs (secondary outcome) in individuals with disordered eating, compared to a no-task control condition (Objective 1). It was predicted that reductions in ED symptoms and of the rational and emotional believability of negative core beliefs would be greatest in the ImRs of early memories condition (Arntz, 2012), followed by the ImRs of intrusive images condition, with the no-task control condition showing no significant effects.

The second objective of the study was exploratory in nature. We looked at the content of rescriptings to identify ‘successful’ and ‘unsuccessful’ scripts, using qualitative content analysis. Further, we assessed the predictive value of each rescripting strategy for disordered eating and core beliefs (Objective 2).

## Methods

### Participants

Participants were recruited through a research participation pool and recruitment flyers around university campus. Participation time was reimbursed by course credits or a gift card (20 Euros).

Participants were pre-screened online using the Eating Disorders Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994) and their body mass index (BMI). Participants scoring between 2.12 and 4.0 on the EDE-Q, and/or with a BMI of > 17.4 were invited to participate in the study. An EDE-Q score between 2.12 and 4 indicates that the level of functioning of the individual is more similar to that of eating disordered patients than non-patients (Machado et al., 2014). A score of 4.0 or higher on the EDE-Q indicates a possible clinical ED (Mond et al., 2006), therefore participants with that score or higher were excluded for ethical reasons given the novelty of our interventions.

In total, 89 participants were recruited, 23 of whom dropped out of the study (see post-hoc analysis for more information). An a priori power analysis using G-Power 3.1 (Faul et al., 2007) was based on the main hypothesis regarding the effects of ImRs on core beliefs and disordered eating. A required total sample size of 66 participants was estimated using G-power for repeated measures ANOVA (within-between interaction), with a small effect size  $f=0.20$ , power set at 0.80, and alpha set at 0.05. The final sample included 66 participants, with one group lacking a participant ( $n=23$  ImRs of autobiographical memories;  $n=21$  ImRs of intrusive images;  $n=22$  no-task control condition). All participants were native Dutch speakers. Descriptive data are presented in Table 1.

### Measures

#### ED Symptoms

The EDE-Q (Fairburn & Beglin, 1994) was used to assess ED symptoms. It is a self-report questionnaire consisting of 32 items rated on a 7-point Likert scale ranging from 0 (*not at all*) to 6 (*every day/markedly*), that measures key ED behavioral features and attitudes about body weight and shape. The EDE-Q has well-established psychometric properties (Berg et al., 2011). Cronbach’s alpha of the EDE-Q total mean score in the present sample was  $\alpha=0.87$ .

The Eating Disorders Inventory-3 (EDI-3; Garner, 1991) is a self-report questionnaire that assesses the symptoms

**Table 1** Descriptive statistics of main baseline and outcome measures

	ImRs-Memory		ImRs-Image		No task-Control	
	Baseline M (SD)	Follow up M (SD)	Baseline M (SD)	Follow up M (SD)	Baseline M (SD)	Follow up M (SD)
Age in years	31.56 (15.34)		26.61 (11.44)		25.31 (10.33)	
BMI	25.36 (4.29)		25.78 (2.97)		25.66 (4.68)	
ED-SCT number of negative core beliefs	7.30 (2.07)		7.90 (2.07)		7.27 (2.64)	
ED-SCT rational believability	67.47 (13.62)	52.38 (16)	56.81 (16.97)	49.41 (21.81)	62.10 (17.64)	63.75 (14.23)
ED-SCT emotional believability	72.73 (12.33)	60.21 (15.12)	72.88 (9.04)	59.78 (20.34)	73.92 (13.24)	75.90 (8.60)
EDBQ	50.11 (14.64)	40.60 (14.37)	45.68 (11.10)	37.93 (17.15)	51.31 (12.19)	50.84 (16.02)
EDI-3	3.58 (0.70)	3.37 (0.70)	3.77 (0.62)	3.51 (0.72)	3.76 (.58)	3.65 (0.67)
EDE-Q	3.38 (.98)	2.90 (.99)	3.19 (.68)	2.83 (.93)	3.36 (.89)	3.27 (.99)
DASS-21 depression	8.73 (5.04)		6.47 (4.79)		8.00 (4.62)	
DASS-21 Anxiety	5.47 (4.16)		4.33 (3.56)		7.00 (4.05)	
DASS-21 Stress	10.56 (5.15)		8.23 (3.78)		11.72 (4.47)	
PTSS-SR	15.73 (8.11)		12.52 (5.96)		15.36 (9.86)	
Total ImRs trials	6.13 (1.09)		6.19 (1.07)			
ECS	2.92 (1.19)					

*BMI* body mass index, *ED-SCT* eating disorder sentence completion task, *EDBQ* Eating Disorder Belief Questionnaire, *EDE-Q* Eating Disorder Examination Questionnaire, *EDI-3* Eating Disorder Inventory-3, *DASS-21* Depression, Anxiety and Stress Scale, *PTSS-SR* Post Traumatic Stress Scale, *ECS* Event Centrality Scale

and more general psychological features related to EDs. It consists of 91 items rated on a 6-point Likert scale ranging from 1 (*never*) to 6 (*always*) and has 12 subscales. In the present study, only the following five subscales were used: drive for thinness ( $\alpha=0.80$ ), bulimia ( $\alpha=0.84$ ), body dissatisfaction ( $\alpha=0.76$ ), perfectionism ( $\alpha=0.72$ ) and interoceptive awareness deficits ( $\alpha=0.14$ ). The EDI-3 generally has acceptable psychometric properties (Clausen et al., 2010). Cronbach's alpha of the EDI-3 total mean score in our sample was  $\alpha=0.83$ .

### Core Beliefs

The ED-related sentence completion task (ED-SCT; Rawal et al., 2010) was used to implicitly assess core beliefs about the importance of one's bodily appearance. It consists of 12 to-be-completed sentences (e.g., "If I always go out of my way to look perfect, people will ... me"). For the purpose of this study, participants were additionally asked to rate the statement completed by them on both rational and emotional believability from 0 (*I do not believe this is true*) to 100 (*I completely believe this is true*). The number of positive sentence completions (e.g., 'admire'; range 0–12) is taken as an index of ED-related core beliefs. Cronbach's alpha for the rational believability was  $\alpha=0.68$  and for the emotional believability  $\alpha=0.66$  in our sample.

The Eating Disorder Beliefs Questionnaire (EDBQ; Cooper et al., 1997) is a self-report questionnaire used to explicitly assess ED-related core beliefs. It consists of 32 items rated on emotional believability ranging from 0 (*I do not usually believe this at all*) to 100 (*I am usually completely convinced that this is true*). It comprises four subscales: negative self-beliefs, weight, and shape as a means of acceptance by others, weight, and shape as a means of self-acceptance, and control overeating. The scale has good internal consistency, test-retest reliability, convergent and discriminant validity (Bergin & Wade, 2014). Cronbach's alpha of the EDBQ total score in the present study was  $\alpha=0.90$ .

### Intrusive Images

The Spontaneous Images Questionnaire (SIQ; Kadriu et al., 2019; Somerville et al., 2007) is a self-report questionnaire used to identify intrusive images when worrying about eating, body weight or shape. Participants are asked to write a detailed description of the image and then rate it on vantage perspective with "0" being "*completely from field perspective*" or first-person perspective and "100" being "*completely from observer perspective*" or third-person perspective, vividness from 0 (*not vivid*) to 100 (*highly vivid*), valence from  $-3$  (*extremely negative*) to  $+3$  (*extremely positive*), and the degree of anxiety that is induced by the image at its worst from 0 (*not at all*) to 100 (*extreme*).

### Autobiographical Memories

The Early Memory Questionnaire (EMQ; Kadriu et al., 2019; Somerville et al., 2007) is a modified version of the SIQ, and was used to identify the content and characteristics of ED-related early memories. Participants were first asked to recall a recent time when they were worried or concerned about their eating or their body weight or shape. Then, they are invited to think about what goes through their mind on such occasions (e.g., a mix of thoughts, mental images, and emotions). Focusing their attention on the emotions and sensations, they are then asked to imagine themselves as a child having the same feelings and see whether a spontaneous memory comes to their mind (c.f., diagnostic imagery using the emotional bridge technique; Arntz & Weertman, 1999). Next, they are asked to describe the memory in detail and rate it on vantage perspective, vividness, valence, and anxiety as in the SIQ.

The Centrality of Event Scale (CES; Berntsen & Rubin, 2006; Vermeulen et al., 2020) was used to measure the centrality of the autobiographical memory identified with the EMQ in the life-story and identity of the participant. It contains 7 items, to be rated on a 5-point Likert scale ranging from 1 (*totally disagree*) to 5 (*totally agree*). The Dutch version of the scale has been shown to have high internal consistency, and its score was positively related to symptoms of PTSD and depression, to the DSM-5 trauma criterion A, and the number of negative life events (Vermeulen et al., 2020). Cronbach's alpha of the CES in the current study was  $\alpha=0.94$ .

### Comorbidity

Given that depression, anxiety, stress, and post-traumatic stress symptoms can be confounding variables, these were measured to test whether groups are comparable at baseline.

The Depression Anxiety Stress Scale-21 (DASS-21; Lovibond & Lovibond, 1995) is a 21-item self-report questionnaire that assesses the current level of depression, anxiety, and stress. Items are rated on a scale ranging from 0 (*never*) to 3 (*almost always*). The total DASS-21 has excellent internal consistency and concurrent validity (Antony et al., 1998). Cronbach's alpha of the total DASS-21 score in this study was  $\alpha=0.91$ .

The PTSD Symptoms Scale-Self Report (PSS-SR; Foa et al., 1993) is a 17-item self-report questionnaire that assesses the frequency of symptoms of posttraumatic stress disorder (PTSD) according to the DSM-IV (APA, 1994). Items are rated on a scale ranging from 1 (*never*) to 4 (*5 times or more per week*). The PSS-SR has a satisfactory internal consistency, high test-retest reliability, and good concurrent validity (Foa et al., 1993). Cronbach alpha of the PSS-SR total score in the present study was  $\alpha=0.85$ .



## Procedure

### Experimental Conditions

**Imagery Rescripting Procedure** The ImRs procedure was identical for the autobiographical memory (ImRs-Memory) and intrusive image (ImRs-Image) conditions. Our ImRs procedure differed from the conventional clinical protocol (Arntz & Weertman, 1999), in that participants were not specifically instructed to experience the image from the adult or the child perspective, given that intrusive images do not necessarily involve a child perspective, and we primarily aimed to keep the experimental instructions as constant as possible for both conditions.

Participants heard verbal pre-recorded rescripting instructions through headphones connected to a PC. They were asked to recall the memory (ImRs-Memory) or intrusive image (ImRs-Image) that they had identified earlier in the SIQ/EMQ and then were instructed to change the image/memory in any way they wanted in order to make it less distressing. They were reminded to note their needs in the image/memory and address them in a way that felt right to them. Participants were asked to describe out loud what was happening in the image/memory during the task, which was audio recorded. Exact instructions are included in Appendix A.

The ImRs manipulation took 9 min in total. Afterwards, participants typed a brief description of the changes they made in the memory/image during the ImRs manipulation.

**No-Task Control Condition** Control participants had a 9-min break and provided a brief description of what they had been thinking about during the break.

### General Procedure

Eligible participants were invited via e-mail to participate in the study. In the lab, all participants first filled out the ED-SCT, EDBQ, EDE-Q, and EDI-3, in this order. Next, participants were randomly assigned to one of the three conditions (ImRs-Memory, ImRs-Image, or the no task control condition). Next, participants in the ImRs conditions filled out the SIQ/EMQ and CES (ImRs-Memory only) and then completed the ImRs manipulation. Then, they rated their rescripted memory/image on vividness, perspective, anxiety, and valence, and wrote a description of the changes they made in the memory/image during ImRs. Participants in the no task control condition had a 9-min break and wrote a description of their thoughts during the break. All participants filled out the DASS-21 and PSS-SR at the end of this session.

After the lab session, participants in the ImRs conditions received an email every day for the next 6 days with

instructions to complete one trial of ImRs online every day. They were free to choose each day whether to rescript the same image/memory or a new one. All participants were asked to return to the lab for a follow-up session 1 week after the lab session, where they completed ED-SCT, EDBQ, EDE-Q and EDI-3 again. Then, they were debriefed, thanked, and received the reimbursement for participation.

Testing was done on a computer using Inquisit 4 (Computer software, 2015) and took around 2.5 h (including lab and online sessions combined). This study was approved by the Ethics Committee Faculty of Social Sciences at Radboud University, ECSW-2018-119R1.

### Coding Scheme

The content of the rescripted memories/images were categorized into five strategies (self-compassion, mastery, unhealthy, avoidance, other strategy), which are described in detail below. ImRs scripts were categorized into ‘mastery’ and ‘self-compassion’, as these have been proposed as possible working mechanisms of ImRs in the literature (Arntz & Weertman, 1999; Wheatley & Hackmann, 2011). The ‘unhealthy’, ‘avoidance’ and ‘other’ strategies were discerned using bottom-up content analysis of ImRs scripts guided by clinical insights of the authors. The content of all rescripted memories/images were coded by one rater (FK), and a randomly selected 10% of all scripts were coded independently by a second rater (JK). The same script could be assigned to more than one category, yet this was never the case. Interrater agreement was very good ( $\kappa=0.80$ ), and all disagreements were resolved through discussion.

### ImRs Strategies

#### Self-Compassion

According to Neff’s (2003) formulation, self-compassion involves being warm and understanding toward feelings of inadequacy, failing, and suffering one may experience, instead of ignoring them or engaging in self-criticism. It also includes acknowledging that these experiences are universal rather than something that happens to you only. Lastly, compassion includes being mindful about one’s thoughts and feelings, which are neither suppressed nor exaggerated. Thus, participants who used self-compassion in their rescripting would use the following: noticing their experiences in a non-judgmental way, accepting, or normalizing their emotional experiences, or taking actions to increase the feelings of warmth, comfort, or safety. For example: “I am feeling less guilt and am being less self-demanding, I accept that I can’t be perfect.”

## Mastery

Mastery refers to the experience of taking an active problem-solving approach in addressing threats or obstacles in order to defend oneself and fulfill unmet basic needs such as safety, autonomy, self-control, expression of needs/emotions and spontaneity (Arntz, 2012). For instance, one may defend oneself from external threats, set boundaries for others, or find a solution for a problem. The need for realistic limits or feeling more in control of unhealthy impulses (e.g., binge eating) was also included in the mastery category. An example is: “I confronted them and told them not to treat me like that.”

## Unhealthy Rescripting

Participants also used unhealthy strategies in the rescripting of their aversive memories or images. Indeed, ED patients often place a positive value on their disorder, such as in being underweight or engaging in disordered eating behaviors, despite associated negative effects (Roncero et al., 2013). Therefore, ED confirming strategies may be identified in rescripting, such as being able to eat only “good” food, reducing body weight or changing body shape. An example: changing the intrusive image of “looking fat” into “a slim person who is in control and enjoys the carrots”. Furthermore, given that individuals with disordered eating tend to be perfectionistic (Fairburn, 2008), they may be excessively demanding and criticizing rather than helpful in their rescripting. For example, one participant rescripted a memory where he felt weak/tired during a working out to “I could lift more aggressively, and I was in a better shape”.

## Avoidance

Avoidance involves directing attention away from the aversive stimulus to an unrelated stimulus (Watson et al., 2015). In other words, the participant was not rescripting the memory or image in a way that addressed the threatening stimuli. Instead, they may escape from them (e.g., leave a stressful social situation), or remove the aversive stimulus without taking action (e.g., a critical mother is simply ignored or not imagined) or hide the aversive stimulus (e.g., wearing baggy clothes).

## Other Strategies

Rescripting that lacked clear descriptions or showed that ImRs was not applied (e.g., rumination, breathing exercises) were categorized as ‘other’.

## Data Analysis

To assess the randomization between groups, we performed chi square tests for categorical variables (gender, education, and marital status) and analyses of variance with age, BMI, ED-SCT, EDBQ, EDE-Q, EDI-3, DASS-21, PSS-SR, and SIQ/EMQ as continuous dependent variables at baseline with condition as the independent variable. Prior to conducting further analysis, dependent variables were tested for normality using the Shapiro–Wilk test. Outliers were checked and defined as values outside of 1st–3rd interquartile range within condition.

To test the first research question, two mixed model MANOVAs were used, with experimental condition (ImRs-Memory, ImRs-Image, no-task control) as the between-subjects factor, time (baseline, follow-up) as the within-subject variable, and core beliefs (ED-SCT emotional and rational believability, EDBQ) and ED symptoms (EDE-Q and EDI-3) as the dependent variables, respectively.

To test the second research question, ImRs scripts were coded into strategies as described in ‘ImRs strategies’ above. For each participant, the proportion of each strategy used was calculated as the number of times the strategy was used divided by the total number of rescripting produced by that participant, resulting in five variables per participant (one for each strategy). Mann–Whitney U tests were used to compare the mean frequency of each ImRs strategy between the two ImRs conditions. Finally, two multivariate linear regression analyses were performed with the strategy variables as predictors, and core beliefs (ED-SCT emotional and rational believability, EDBQ) and ED symptoms (EDE-Q and EDI-3) as the dependent variables, respectively.

## Results

### Descriptive Data

Means and standard deviations of demographic and clinical measures at baseline are presented in Table 1. About half of participants (45.3%) were within the healthy BMI range (18.5–24.99; WHO, 2006), and 54.7% of participants were overweight or obese (BMI > 24.99). All participants reported that they engaged in some form disordered eating behaviors, with binge eating (78.8%) and driven exercise (81.8) being the most common. Only few participants reported self-induced vomiting (1.6%) or misuse of laxatives (4.8%). Finally, 75.8% of our sample reported global eating pathology (EDE-Q) above the clinical cut off score, 2.77, which is the norm for young adult women (Mond et al., 2006).

There were no significant group differences (all  $p > 0.05$ ), except for the DASS-21 Stress subscale. Participants in the ImRs-Image condition had a significant lower score than

those in the control condition ( $p=0.04$ ), whereas there were no other differences between the conditions,  $F(2, 63)=3.16$ ,  $p=0.04$ ,  $\eta^2=0.09$ . In further analysis we controlled for the DASS-21 Stress level at baseline.

## Task Compliance

On average, participants completed  $M=6.1$  ( $SD=1.07$ ) ImRs trials. ImRs scripts that were coded into the ‘other’ category were classified as lacking task compliance, i.e., no imagery rescripting was applied. In total, 6.15% ( $n=16$ ) ImRs scripts did not adhere to the ImRs instructions. Given that participants tended to be compliant in at least some of the ImRs trials, all participants were included in the final data analysis.

## Objective 1

### Changes in Eating Disordered Behavior

The mixed model MANOVA showed an overall significant main effect of time ( $F(2, 61)=16.02$ ,  $p<0.001$ ,  $\eta_p^2=0.34$ ), revealing an overall reduction in ED symptoms from baseline to follow-up, across conditions. There was no significant main effect of group nor a significant interaction effect, both,  $p<0.08$ . The univariate tests of the EDE-Q, however, showed a significant interaction effect,  $F(2, 62)=3.88$ ,  $p=0.02$ ,  $\eta_p^2=0.11$ . Participants in the ImRs-Memory and ImRs-Image conditions showed significant reductions in EDE-Q scores from baseline to follow-up,  $t(21)=3.86$ ,  $p=0.001$ ,  $d=0.82$ , and  $t(20)=3.36$ ,  $p=0.003$ ,  $d=0.73$ , respectively; whereas there was no significant change in the control condition,  $t(21)=1.09$ ,  $p=0.28$ . For the EDI-3, there was no significant interaction effect,  $p<0.39$ . Supplementary results are included in Appendix B.

After controlling for the DASS-21 Stress level at baseline, the mixed model MANCOVA showed no significant main effect of time, interaction effect or group. The univariate tests of the EDE-Q still showed a significant interaction effect,  $F(2, 61)=3.97$ ,  $p=0.02$ ,  $\eta_p^2=0.11$ . There was no significant interaction effect for EDI-3,  $p<0.09$ .

### Changes in core beliefs

The mixed model MANOVA demonstrated a significant main effect of time  $F(3, 61)=6.17$ ,  $p=0.001$ ,  $\eta_p^2=0.223$ , and a main effect of group  $F(6, 122)=2.73$ ,  $p=0.01$ ,  $\eta_p^2=0.118$ , which was driven by a significant interaction effect,  $F(6, 122)=2.70$ ,  $p=0.01$ ,  $\eta_p^2=0.117$ . The interaction was significant for the ED-SCT rational believability,  $F(2, 63)=5.79$ ,  $p=0.005$ ,  $\eta_p^2=0.15$ . Pairwise comparisons showed that the rational believability significantly decreased from baseline to follow-up in the ImRs-Memory condition,

$t(22)=3.82$ ,  $p=0.001$ ,  $d=0.80$ , but not in the other two conditions, both  $p<0.07$ .

For the ED-SCT emotional believability, there was a significant interaction effect as well,  $F(2, 63)=5.69$ ,  $p=0.013$ ,  $\eta_p^2=0.13$ . Participants in both ImRs conditions reported significant decreases from baseline to follow-up,  $t(22)=3.18$ ,  $p=0.004$ ,  $d=0.66$ ;  $t(20)=2.69$ ,  $p=0.01$ ,  $d=0.58$ , respectively, whereas those in the no task control condition did not,  $t(21)=-0.69$ ,  $p=0.49$ . Further, post-hoc comparisons of the main effect of condition at follow-up showed significantly lower emotional believability for participants in both ImRs conditions (no significant difference,  $p>0.999$ ) compared to the no task control condition (both  $p=0.02$ ,  $d=0.34$ ).

Finally, for the EDBQ there was no significant group or interaction effect ( $p>0.054$ ). Supplementary results are included in Appendix B.

After controlling for DASS-21 stress level at the baseline, we no longer find a main effect of time, but the interaction effect  $F(6, 122)=2.78$ ,  $p=0.014$ ,  $\eta_p^2=0.12$ , and that of group remains  $F(6, 122)=2.25$ ,  $p=0.04$ ,  $\eta_p^2=0.10$ . Univariate tests also reveal same significant effects as in the original analysis (all  $p<0.03$ ).

## Objective 2

### Content Analysis of ImRs Scripts

See Table 2 for examples of ImRs strategies, and Table 3 for frequency and group comparisons for each strategy. Participants completed 262 ImRs trials cumulatively, during which they used the ImRs strategies in following order: self-compassion (32.82%), unhealthy rescripting (24.81%), mastery (22.52%), avoidance (11.45%) and other strategies (6.11%). The mean percentage of adaptive strategies (self-compassion, mastery) per participant was 54.33% ( $SD=36.26$ ) in the ImRs-memory condition, and 52.27% ( $SD=39.49$ ) in the ImRs-image condition, with no significant differences between the two conditions ( $p=0.858$ ). However, participant in ImRs-Image condition used significantly more unhealthy rescripting than participants in ImRs-Memory condition ( $U=132.0$ ,  $p=0.006$ ). Further, 20% ( $n=9$ ) of participants in the ImRs conditions did not use self-compassion or mastery in any ImRs trial. Two multivariate regression analyses were performed to examine the predictive value of each strategy on core beliefs (ED-SCT emotional and rational believability, EDBQ) and disordered eating (EDE-Q, EDI-3). Neither model was statistically significant, both  $p>0.382$ .

### Post-hoc Analysis of Dropouts

About one quarter of participants ( $n=23$ , 25.8%) dropped out of the study after the lab session or first online ImRs

**Table 2** Examples, frequency of each content category

Original image/memory	Meaning associated with the image/memory	ImRs script
<p><b>Mastery</b></p> <p>I have a bigger belly after dinner and my mother and brother don't like it. My mom calls me fat and keeps telling me to lose weight. I want to cry, but I don't. My brother gives me a drawing he made of me: I have 2 large bumps on my body, one of which is my stomach and one my buttocks. I get angry and scream. I feel hurt, it hurts. I go to my room and cry because I find myself ugly</p> <p><b>Self-compassion</b></p> <p>I was on a birthday and suddenly I became very quiet there and suddenly I looked at everything from a distance. That's how it seemed. Because I was in a kind of shock because suddenly, I felt so very worthless. I was not nice I was too fat and not beautiful and I was also extremely shy and could not behave as lightly as the others. I thought I was the only one so different at the time. In my opinion it took a long time before I could say a word again and participate in the party again. Way too long. I was ashamed of myself It must have been noticed by the rest how "weird" I was</p> <p><b>Unhealthy</b></p> <p>I'm in my room. On my bed are shorts and shirts that I am trying on for the summer. I notice that the shorts are tighter around my waist and that the shirts are also tight around my belly. My belly protrudes and you see my belly button. I look at myself in the mirror</p>	<p>That other people gave me a view that I never thought about and that hurt me so much. I was just weak and said nothing about it, just crying</p> <p>That I was no longer able to hide how unhappy I suddenly was</p>	<p>When my mom and brother call me fat, I don't get angry and don't start crying. I don't run away. I indicate that I am not fat. I'm good the way I am, I'm better than them. I feel the support of someone, myself, in this action. Someone who says I can be there. I am strong. I have this</p> <p>I intervene in time with myself and say to myself: Come on, you can also be there. You are invited to this party for a reason. Apparently, you are nice enough. Just join in again and don't worry too much. Because of this I come out of my negative spiral. I stop myself. I join again</p>
<p><b>Avoidance</b></p> <p>I look down and see a muddy belly. My thighs are thick and I can hardly see my toes anymore. I hold my stomach and experience the large amount of fat on my stomach. When I sit, my pants are hanging on all sides</p> <p><b>Other</b></p> <p>I was chubby and I saw that other girls had a much less fat figure. Some of the friends were really skinny (they were top gymnasts or jazz ballet dancers; a boyish figure was retained at that age my aim,</p>	<p>The worst thing about this memory is my protruding belly, which makes me feel fat</p> <p>I don't feel beautiful and very uncomfortable in my skin</p> <p>That I didn't notice, at that age, that my truth was not truth at all. I really believed that having less fat meant having more happiness/fun</p>	<p>In my rescripted memory I have a flat stomach and the clothes fit nicely on my body</p> <p>I put on big clothes that hide it. In addition, I move from myself and look at my body as that of someone else. I don't mind if it's someone else, I wouldn't pay attention to that. Others don't do that to me either</p> <p>I could have shared my finding of terror right away with another friend who was also present on the birthday. Then I wouldn't have had to struggle with it for years. With my weight. In the meantime, I could have participated much better at the birthday. And just enjoy it instead of worrying</p>



**Table 3** Differences in ImRs strategies between the experimental conditions

	Total N (%)	ImRs- memory M (SD)	ImRs- image M (SD)	Difference
Mastery	N = 59 (22.52%)	27.31 (29.42)	14.62 (21.73)	U = 180, p = .126
Self-compassion	N = 86 (32.82%)	27.02 (27.43)	37.65 (37.52)	U = 212.50, p = .484
Unhealthy	N = 65 (24.81%)	12.80 (23.44)	39.08 (35.60)	U = 132.0, p = .006**
Avoidance	N = 30 (11.45%)	16.98 (22.36)	6.05 (12.36)	U = 175.0, p = .070
Other	N = 16 (6.11%)	12.06 (27.41)	1.9 (6.01)	U = 209.0, p = .230

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

trial. There were no differences in dropout rates between the two ImRs conditions,  $\chi^2(1) = 0.798$ ,  $p = 0.612$ . However, none of participants in the no task control condition dropped out. We explored the differences between dropouts and non-dropouts on age, BMI, ED-SCT, EDBQ, EDE-Q, EDI-3, image/memory and ImRs vividness, perspective, anxiety, emotionality, and ImRs strategies (first trial only). Participants who dropped out tended to be younger in age ( $M_{dropout} = 23.39$ ,  $SD_{dropout} = 4.28$ ;  $M_{non-dropout} = 29.75$ ,  $SD_{non-dropout} = 14.03$ ,  $t(66) = 2.19$ ,  $p = 0.038$ ), and reported significantly lower anxiety associated with the image/memory on the SIQ/EMQ ( $M_{dropout} = 46.21$ ,  $SD_{dropout} = 23.22$ ;  $M_{non-dropout} = 64.75$ ,  $SD_{non-dropout} = 21.15$ ,  $t(66) = 3.30$ ,  $p = 0.002$ ). Other  $p$ 's  $> 0.05$ .

## Discussion

The main aim of the present study was to investigate the effects of ImRs of early memories versus ImRs of intrusive images compared to a no task control condition, on negative core beliefs and disordered eating in individuals at risk of developing an ED. Contrary to predictions, both ImRs conditions reduced negative core beliefs and disordered eating symptoms (as measured with the EDE-Q) compared to a no task control condition. In line with predictions, only ImRs of early memories resulted in a significant reduction of rational believability of core beliefs. Exploratory analyses revealed that the most widely used rescripting strategy was self-compassion, followed by unhealthy ED-confirming strategies. However, we did not find significant associations between the ImRs strategies and any of the outcome measures. Finally, the drop-out rate in the ImRs groups was unexpectedly high, over 25%, with drop-outs being younger, and reporting lower anxiety associated with their early memory or image in the first ImRs trial.

The effects of ImRs of early memories and intrusive images did not differ significantly on most study outcomes. This was a surprising finding, given our hypothesis. Intrusive images are a derivative of memories (Conway et al., 2004), therefore it has been postulated that rescripting is

more effective when targeted directly at the underlying early memory (Arntz, 2020). On the other hand, our results align with the idea that intrusive images may provide relatively easy access to core beliefs that drive ED symptoms (Hinrichsen et al., 2007; Somerville & Cooper, 2007). As such they could be a useful target in therapy (Krans et al., 2009). It should however be noted that participants in the ImRs of intrusive images condition were more likely to use unhealthy ED-confirming strategies. Further, ImRs of early memories, as expected, resulted in larger reductions in the rational (but not emotional) believability of core beliefs than ImRs of intrusive images. This supports the hypothesis that targeting early memories more directly changes core beliefs than targeting images. However, in the absence of other differential effects among the ImRs conditions, this result requires replication before firm conclusions can be drawn.

About 55% of the scripts included mastery or self-compassion strategies, which have been proposed as functional strategies in the ImRs literature (Arntz & Weertman, 1999). However, this also shows that the other half of strategies used were unhealthy, avoidance, or no rescripting. It has been proposed that interventions applied during ImRs should challenge key dysfunctional meanings associated with the memory/image for the ImRs procedure to be effective (Wheatley & Hackmann, 2011). Yet, surprisingly, no relations between the frequency of strategies used and outcomes was found. At first glance this may suggest that the strategies used do not matter. However, this would be rather unlikely as previous studies have reported that an increase in self-compassion and mastery mediates the effect of ImRs (e.g., Pennesi & Wade, 2018; Strohm et al., 2019). Furthermore, participants used self-compassion or mastery on average on half of the trials (although 20% of participants did not use adaptive strategies at all) and we did not measure the actual level of mastery or compassion that participants experienced after the ImRs procedure. We therefore cannot draw any strong conclusions as to the ImRs strategy effects. To disentangle these effects further, we are currently testing ImRs focused on mastery versus ImRs focused on self-compassion in a new sample of this at-risk population.

The finding that participants used functional ImRs strategies only half of the time also impacts the conclusions that can be drawn for Objective 1. That is, the effects may have been different or stronger, if participants had used adaptive strategies more frequently. As previous studies typically have not reported the used strategies qualitatively, the use of non-adaptive ImRs scripts may also have been a problem in earlier studies (e.g., Pennesi & Wade, 2018; Zhou et al., 2020). Indeed, a recent study in social anxiety explored the strategies that patients used during a single ImRs session and, strikingly, 43% of the participants chose at least one avoidant strategy even though in this study the ImRs was therapist guided (Romano et al., 2020). These findings highlight that for individuals prone to avoidance more guidance in rescripting may be necessary.

Notably, the high dropout rates in the ImRs conditions were surprising, given a general low dropout rate for ImRs (Arntz, 2012). Younger participants and those who reported lower anxiety associated with their early memory or intrusive image were more prone to drop out. This may indicate lack of motivation, or perhaps these participants selected less anxiety provoking images/memories, or inhibited the full emotional experience associated with the selected image/memory. Indeed, individuals who struggle with ED tend to be secretive and defensive about their symptoms, and often do not seek help (Becker et al., 2004). The feedback from participants that dropped out confirms part of these explanations. Half of participants who dropped out claimed that the ImRs was very distressing. For example, one participant noted that they were too self-critical to be able to disagree with what happened in the image. Other cited reasons were feeling uncomfortable to share personal information or finding the study too time consuming.

The present study has several limitations. We investigated a modified form of ImRs, which was self-guided, shorter and did not include the three phases of ImRs as in the original clinical procedure (Arntz & Weertman, 1999). A self-guided ImRs protocol may pose an important disadvantage for individuals who may be unable to play an active role in correcting the problematic situation or may find it hard to provide or receive warmth and compassion, and thus intervention by a therapist is warranted (Arntz, 2012). Moreover, the ImRs protocol did not require the participant to take the child's perspective which helps to better recognize one's unmet needs, and instead only the adult's perspective was used to make interventions to address these needs (Arntz & Weertman, 1999). Therefore, it is possible that the results may have been different if the original procedure had been used. Further, given that we coded ImRs strategies based on the written descriptions provided by the participants, we cannot exclude the possibility that these participants used other strategies as well. We recommend that future studies measure self-reported levels of compassion and mastery

during the ImRs manipulation. Finally, it is also possible that the participants showed a demand effect which led them to rate items on negative core beliefs and ED symptoms lower at the follow up. To control for this possible confound, future studies should include a placebo control group.

Additionally, the mean BMI in our participants was higher than the normal range, and most participants reported episodes of binge eating and driven exercise. This indicates that our sample may represent participants with more bulimic/binge eating symptoms rather than those with restrictive eating. Hence, the generalizability of these results is limited to a population more prone to bingeing and impulsivity, and future studies should aim to include participants with restrained eating as well. Finally, the interoceptive awareness deficits subscale of EDI-3 had a very low internal reliability. Therefore, results concerning the effect of ImRs on this scale cannot be reliably interpreted.

To conclude, this study provides initial evidence on the usefulness of ImRs of early memories as well as ImRs of intrusive images in the treatment of (subclinical) ED, potentially through the change in core beliefs. It will be important to replicate our findings and to further investigate ImRs in clinical samples. Our results further suggest that individuals with disordered eating need therapeutic assistance to come to healthy rescripting. A more directive approach from the therapist may be appropriate in these cases (Arntz, 2012). Future research is needed to decide self-guided ImRs differs from therapist assisted ImRs, and whether the original format with three phases is more effective. And finally, given that the ImRs may be experienced as highly demanding in terms of emotional and cognitive efforts, providing more preparation and explanation of the ImRs technique beforehand may help in preventing dropout (Arntz, 2011).

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**Data Availability** Anonymized data can be obtained using the following link: [https://osf.io/rz8jn/?view\\_only=8cd6c3e5da114ede8a7148633db1dc58](https://osf.io/rz8jn/?view_only=8cd6c3e5da114ede8a7148633db1dc58)

## Declarations

**Conflict of interest** Fortesa Kadriu, Laurence Claes, Cilia Witteman, Julie Krans declare that they have no conflict of interest.

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

**Animal rights statements** No animal studies were carried out by the authors for this article.

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