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The role of simulation in imagery rescripting for post-traumatic stress disorder: a single case series

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Abstract

Background: Imagery rescripting (ImRs) is an experiential therapy technique used to change the content and meaning of intrusive imagery in post-traumatic stress disorder (PTSD) by imagining alternative endings to traumatic events. There is growing evidence that ImRs is an effective treatment for PTSD; however, little is known about how it brings about change.
Aims: This study aimed to explore the role of mental simulation as a candidate mechanism of action in ImRs, and, specifically, whether well-simulated imagery rescripts are associated with greater change in symptom severity during ImRs.
Method: Using a single-case experimental design, seven participants receiving cognitive therapy for PTSD were assessed before, during and after sessions of imagery rescripting for one intrusive image. Participants completed continuous symptom severity measures. Sessions were recorded, then coded for goodness of simulation (GOS) as well as additional factors (e.g. rescript believability, vividness).
Results: Participants were divided into high- and low-responders and coding was compared across groups. Correlational analyses were supported by descriptive analysis of individual sessions. High-responders' rescripts tended to be rated as well-simulated compared with those of low-responders. Specific factors (e.g. intensity of thoughts/emotions related to original and new imagery elements, level of cognitive and emotional shift and belief in the resultant rescript) were also associated with reductions in symptom severity.
Conclusions: There was tentative evidence that well-simulated rescripted images tended to be associated with greater reductions in symptom severity of the target image. Clinical implications and avenues for further research are discussed.

Keywords: imagery rescripting; mental simulation; post-traumatic stress disorder; traumatic memory

Introduction

Imagery rescripting (ImRs) is a therapeutic intervention that involves imagining alternative, hypothetical endings to traumatic events. Used to target intrusive images in post-traumatic stress disorder (PTSD) (Rusch *et al.*, 2000), ImRs contrasts with imaginal exposure/reliving techniques in trauma-focused cognitive behavioural therapy (CBT), which typically involve vividly and realistically reliving the trauma memory as it actually happened (Ehlers and Clark, 2000; Foa and Rothbaum, 1998).

While there is a growing body of evidence supporting the effectiveness of ImRs in reducing PTSD symptomology (e.g. Arntz *et al.*, 2007; Ehlers *et al.*, 2005; Grunert *et al.*, 2007), there is also a recognition of the need for further systematic research into its underlying change mechanisms (Arntz, 2012) and the aspects of therapy that bear upon these mechanisms. Two competing ideas as to how ImRs might produce change have emerged. Applying a retrieval competition account (Brewin, 2006; Brewin *et al.*, 2010), ImRs may create a competing, less distressing memory representation of the traumatic event, which is more accessible than the original memory in response to retrieval cues and therefore preferentially retrieved, inhibiting the old image (Brewin *et al.*, 2009). Others have argued that ImRs changes the underlying meaning of the original memory image such that when triggers are encountered, an altered, less-distressing memory representation is recalled (Arntz, 2015; Arntz and Weertman, 1999).

There is considerable variation in approaches to conducting ImRs sessions (e.g. Arntz and Weertman 1999; Smucker and Niederee 1995; Wild and Clarke, 2011), so improving our understanding of how ImRs elicits change in the memory representation could help inform how to best deliver the technique (Arntz, 2012). To provide a basis for gaining further knowledge in this domain, Salter *et al.* (2015) developed a comprehensive coding scheme based on close analysis of the content of ImRs sessions during PTSD treatment. Textual analysis of session transcripts using the coding framework suggested various discernible processes, including the activation of thoughts and feelings, cognitive and emotional shifts, and believability of the rescript. Preliminary evidence for the association of these factors with ImRs efficacy was also demonstrated in a series of cases (Salter *et al.*, 2015).

The present study builds on this research by moving beyond 'bottom up' processes that are directly observable within therapy sessions. Instead, it considers a conceptual 'top down' property of rescripted images, namely the quality of their mental simulation. According to the simulation heuristic (Kahneman and Tversky, 1982; Tversky and Kahneman, 1973), the properties of imagined scenarios that lend them believability relate to the ease with which a mental model of a hypothetical situation can be created. In people with clinical levels of anxiety, this 'goodness of simulation' (GOS; how well they could simulate a hypothetical event in imagination) has been associated with higher subjective probability ratings for hypothetical, negative events as well as increased access to these simulations (Raune *et al.*, 2005). Similarly, when simulating imagined positive outcomes to future stressful events, better simulations have been linked to higher subjective probability ratings and less worry (Brown *et al.*, 2002). GOS may therefore contribute to an understanding of how ImRs might work. Specifically, both ImRs and GOS relate to the mental construction of imagined events that did not, or could not, happen. It may be that rescripted images that are better simulated, and so more accessible, are therefore more compelling (believable), and so more effective in competing with or modifying PTSD intrusive imagery. In this way the present study considers whether effective ImRs targets intrusive imagery by enhancing the simulation, and hence believability, of new, less distressing images and their associated meanings (Arntz, 2012).

Current study

The broad aim of this study was to examine aspects of ImRs that may account for therapeutic change. Explanations of *how* and *why* effective therapies work are crucial for optimising therapy to produce change (Kazdin, 2007). In the face of the inherent complexity of this type of research, and the large number of potential factors interacting dynamically, one potential strategy would be to focus on a small, manageable set of potential ImRs change factors across a large number of participants while attempting to keep potential confounding factors constant. However, it has been argued that research questions that focus on investigating functional relationships between variables and the processes underlying particular phenomena do not lend themselves to traditional null-hypothesis significance testing (Smith and Little, 2018). Furthermore, conducting a larger scale confirmatory study poses two main difficulties: (1) how to identify those ImRs factors that should be targeted for investigation and (2) running the risk of excluding variables that could be central to the process of therapeutic change in ImRs. Sidman (1960) has highlighted the importance of identifying the relevant

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controlling variables for the phenomenon under study and argues that small-*n* designs are the most appropriate approach for this purpose.

Studies of small samples of cases in greater detail is considered preferable when the research question relates to the processes and conditions that give rise to a particular effect, rather than demonstrating the existence of a particular phenomenon (Normand, 2016). In this way, a wider range of variables can be encompassed within the study to determine which factors seem to be the most promising in terms of accounting for change during ImRs, paving the way for subsequent, larger scale confirmatory studies (Smith and Little, 2018).

In line with these considerations, the present study employed a single case experimental design (SCED). SCEDs involve comparing performance under different conditions within an individual, rather than either within or between groups (Kazdin, 1978). A number of single cases can be tracked, allowing for patterns to emerge across a series of individual cases. Rather than using a control group, SCED relies on repeated measurement, following participants for a period of time before and during treatment (Turpin, 2001).

Seven participants were followed before, during and after rescripting of one image during treatment for PTSD. Participants completed continuous measures of the frequency and distress of images across sessions. To capture the dynamic processes at play in ImRs, recordings of sessions were coded using two separate coding schemes. The first was a refined version of the Session Content scheme of Salter *et al.* (2015), designed to capture those aspects of ImRs that are directly observable. The GOS coding scheme (Rose *et al.*, 2019) was also used to capture less readily observable characteristics such as logical flow, ease of imagining and sequencing. It was hypothesised that reductions in frequency and distress would be associated with higher GOS ratings and that aspects of the ImRs process previously shown to be associated with improvement (e.g. cognitive and emotional shift, rescript believability) would also be associated with a better outcome.

Method

Participants

All participants had a PTSD diagnosis, experienced intrusive traumatic memories and were undertaking trauma-focused CBT treatment with an ImRs component in a routine clinical setting. Of ten participants initially recruited, one withdrew from the study before the first rescripting session. ImRs treatment was delayed for two, meaning they could not participate within the study time frame. The final sample of seven (five female, two male) had a mean age of 30.7 years ($SD = 9$; range = 20–45) and were from a range of ethnic backgrounds. All but one had experienced more than one traumatic event. See Table 1 for individual participant details. To protect participant anonymity, some details have been changed.

Measures

Within SCED research, idiographic measures of the construct of interest that are sensitive to small changes over a short time period are preferable to standardised diagnostic measures designed to detect broader clinical change at a group level over longer periods (Morley, 2018). The set of measures described below reflects these considerations.

Frequency, distress and symptom severity

Frequency and distress of the target image were measured using two of Brewin *et al.*'s (2009) self-report visual analogue scales (VASs), requiring participants to rate the target image on a 0–100 scale. Frequency and distress were also combined to form a pre-/post-measure of symptom severity. This conceptualisation of PTSD symptom severity, combining frequency and distress,

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Table 1. Individual participant demographic information and symptom severity scores before and after ImRs

P	Gender	Age	Ethnicity	Previous treatment	Time since trauma	Current treatment duration	Symptom severity before	Symptom severity after
1	F	35	Indian	Counselling (12 sessions), CBT for anxiety (20 sessions)	8 years	9 months (24 sessions)	91.67	52.5
2	F	23	British	Counselling ×2, EMDR ×2, TF-CBT, Community Mental Health Team	9 years	9 months (29 sessions)	46.67	5
3	M	25	Indian	Counselling, IAPT	6 years	16 months (29 sessions)	81.67	60
4	F	45	Spanish	EMDR	7 years	6 years 4 months (189 sessions)	61.67	17.5
5	F	29	Middle Eastern	IAPT (20 sessions)	3 years	11 months (35 sessions)	68.33	35
6	F	38	Irish	IAPT and unspecified service (30 sessions total)	1 year	5 months (31 sessions)	65	55
7	M	20	Bangladeshi	None	11 years	6 months (8 sessions)	60	50

is consistent with the approach taken by the Clinician-Administered PTSD Scale (CAPS-5), the gold standard clinical interview for PTSD assessment (National Centre for PTSD, 2016; Weathers *et al*., 2001).

GOS coding scheme

The current version of the GOS coding scheme was adapted from that of Rose *et al*. (2019) and consists of six codes (logical sequencing, temporal ordering, minimisation of uncertainty, level of detail, easy of imagining, smooth flow). Each code was rated on a 3-point scale (1 = not true or mostly not true, 2 = partially true, and 3 = mostly true). Inter-rater reliability was assessed by two raters on ImRs recordings from an archival sample comparable to the current sample. Discrepancies were resolved through discussion and the coding scheme adjusted accordingly.

ImRs session content coding scheme

Each session was coded using nine codes adapted from the Salter *et al*. (2015) coding scheme. Based on previous experience with the coding scheme, 'imagery activation' for original and new imagery was coded separately, instead of a single overall code, leading to a total of ten codes. Codes are summarised in Table 2 and each was rated on a scale of 0–3. The full coding scheme can be found in the Supplementary material.

Design and procedure

The aim was to implement a SCED design naturalistically so as not to disrupt the course of routine treatment. Participants were enrolled at any point prior to the week before the imagery rescripting component of their therapy, and followed for the duration of the therapeutic work on a single intrusive image. All had undertaken imaginal exposure/reliving of traumatic memories prior to undertaking ImRs sessions. Data collection began 1 week prior to the first rescripting of the target image. During this session, patient and therapist collaboratively identified the target image for subsequent rescripting. No therapeutic work in relation to the image took place

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Table 2. Summary of session content codes

Image departure	Extent to which the rescript departs from the original imagery in terms of the amount of new material being introduced
Timing of change	The point in time when new information is introduced into the imagery
Staying with imagery	Participant's ability to continuously activate and stay with the imagery throughout the rescripting process
Therapist guidance	Participant's ability to follow the rescripting process and incorporate changes without significant guidance from the therapist
Original imagery activation	Participant's ability to visualise original imagery elements as indicated by vividness of description
New imagery activation	Participant's ability to visualise new imagery elements as indicated by vividness of description
Original processes	Level of activation of emotions, cognitions and/or physical sensations associated with original imagery elements
New processes	Level of activation of emotions, cognitions and/or physical sensations associated with new imagery elements
Cognitive/emotional shift	Extent to which the meaning associated with the original imagery changes during the rescripting process
Believability of rescript	Extent to which the rescript feels believable and compelling to the client *regardless of whether it is physically possible*

during this session. VAS measures were completed during this session, once during the following week and again at the start of the following session (first rescripting session), giving a total of three baseline points. Participants then commenced re-scripting sessions of the target image. While a specific ImRs protocol was not stipulated, the process generally followed those previously used by Arntz and Weertman (1999), Wheatley and Hackmann (2011), Smucker *et al.* (1995) and Smucker and Dancu (2005). Treatment was carried out in a specialist, trauma-focused CBT service by clinical psychologists also trained in ImRs by Arnold Arntz. Having identified a target image and specified the associated cognitions and emotions, patient and therapist collaboratively agreed how the image might be rescripted before engaging in the rescripting process. A wide range of rescripting methods were employed (e.g. bringing other people into the rescript, changing the behaviour of oneself or others, altering the perpetrator or the surroundings in some way, etc.), and additional elements added iteratively as the rescript was elaborated. Rescripts varied widely in the amount of therapist direction, between the more directive, multi-stage methods of Arntz and Weertman (1999), and the more Socratic imagery method of Wheatley and Hackman (2011). Additonal ImRs sessions were added as needed to consolidate and enhance rescripts, or to address new cognitions and emotions that had emerged through the ImRs process.

The image distress VAS was administered at the start and end of each rescripting session. The image frequency VAS was administered only at the start of each session (as the frequency VAS asks the participant to rate 'frequency over the past 3 days', it did not make sense to administer this twice in an hour). The ImRs phase lasted for the number of sessions required to rescript one image, but in the interest of consistency across cases, participants were followed for a maximum of three sessions. Thus, each participant was followed for the duration of one image, up to a maximum of three sessions. Given that the aim of this study was to explore processes within ImRs, rather than assessing overall efficacy, this level of variation in session numbers was deemed acceptable. In keeping with the naturalistic design of this study, clinical judgement and patient choice were used to determine when sufficient rescripting had been completed for the target image. All sessions were recorded. When rescripting of the target image was complete (or after three ImRs sessions), participants completed the VAS measures at the beginning of the following session as a follow-up data point. In cases where this follow-up session involved no therapeutic work (e.g. discussions about therapy direction, practical tasks such as assistance with paperwork) VAS measures were collected again the following week as a second follow-up point. All sessions were

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coded individually using both the GOS and session content coding schemes. The session content coding scheme produced ten separate codes rated on an anchored scale between 0 and 3. The GOS coding scheme provided six codes rated between 1 and 3. Internal consistency of GOS codes has been found to be high (α > .9) in previous studies (e.g. Huddy *et al.*, 2012; Keen *et al.*, 2008), thus an overall GOS score for each participant was obtained by summing the six individual scores. In order to create a GOS scale range of 0–12 (rather than 6–18 which resulted from each item being scored on a scale of 1–3), each total score was reduced by 6 points. GOS ratings can be considered as high (9–12), medium (5–8) or low (1–4).

Results

This section outlines associations between codes and outcomes for participants. There is debate in the literature about the use of conventional parametric statistics in SCED, which are thought to increase threats to validity (Shadish *et al.*, 2013). Thus data were analysed using both parametric statistics and descriptive observations commonly used in SCED. Firstly, participants were divided into high- and low-responders using the reliable change index (RCI) (Jacobson and Truax, 1991). Following this, links between codes and outcome were explored using three approaches: individual SCED analysis, descriptive statistics at group level and, finally, GOS and individual session content codes were correlated with symptom severity change.

Reliable change

Six cases encompassing 18 sessions were coded by two researchers using the session content coding scheme. Discrepancies greater than 1 rating point were only found in 2.1% of the ratings. Intra-class correlation between the raters was 0.81, indicating acceptable agreement (>0.7). For the GOS coding scheme, one session from three cases (50% sample, 17% of sessions) was coded by two researchers. Ratings were never discrepant by more than 1 point. The intra-class correlation (0.78) was acceptable.

Symptom severity was used to calculate reliable and clinically significant change following rescripting (Jacobson and Truax, 1991). Table 1 summarises pre- and post- symptom severity scores. The RCI ($RCI = (M_1 - M_2)/SE_{diff}$) was calculated for the difference between pre- and post-ImRs scores. SE_{diff} was calculated using the test–retest reliability based on the first two baseline scores. RCI > 1.96 (+2*SD*), equating to a difference score of 38 in symptom severity, were considered to reflect reliable change. Pre-ImRs data was based on the average of each participant's three baseline scores. Post-ImRs scores were based on participants' follow-up score (or average of follow-up scores where available). Four participants (P1, P2, P4 and P5) met criteria for reliable change and are referred to as high-responders. The latter three also met criteria for clinically significant change. P3, P6 and P7 did not meet criteria for reliable or clinically significant change and are referred to as low-responders. The Leeds Reliable Change Indicator (Morley and Dowzer, 2014) was used to graph the results (see Fig. 1).

Individual SCED analysis

Visual SCED analysis involves determining baseline stability[1], assessing level, trend and variability of data within each phase, and comparing phases to consider whether patterns of level, trend and

[1]All baseline data met stability criteria except for that of P2 (distress and frequency), which showed stable or increasing trend for the first two baseline points followed by a significant decrease for baseline point 3. P2 reported that she spontaneously started to rescript the image independently after completing the second baseline measure, potentially explaining this variability.

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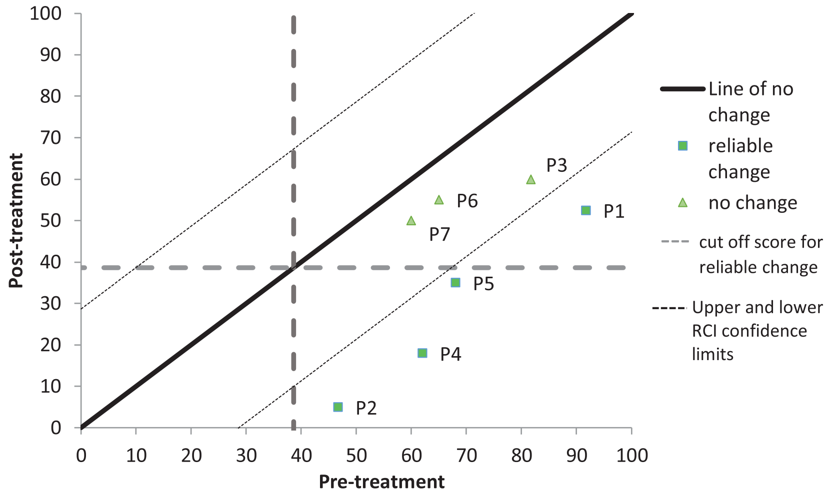

Figure 1. Scatter plot of pre- and post-symptom severity scores.

variability change across phases (Kratochwill *et al*., 2010). Overlap of data between phases can also be assessed. (A detailed plan for SCED analysis, along with frequency and distress graphs and individual coding across sessions for all participants can be seen in the Supplementary material.) Patterns of level, trend and variability within and across phases for high- and low-responders are summarised below followed by a synthesis of coding patterns across sessions and how these appeared to differ for high- and low-responders.

Overall, high-responders (P1, P2, P4, P5) experienced small to moderate changes in frequency and large decreases in distress during the treatment phase. Small to medium changes tended to be stable and sustained at follow-up. While some larger changes seen during treatment were sustained, others were more variable and would often increase at follow-up but still remain below baseline levels. Low-responders experienced no change or small, but reliable, changes (P3, P7) in distress and frequency. There was one exception to this where P6 experienced large changes during treatment (possibly facilitated by high levels of therapist prompting) that returned to baseline at follow-up.

Table 3 describes apparent different configurations of codes for high- and low-responders across sessions. Higher GOS, cognitive/emotional shift and rescript believability, and lower levels of therapist guidance appeared to be associated with larger and more consistent changes in frequency and distress. Introducing change during (rather than before) the most distressing part of the trauma image/memory also appeared to be associated with better outcomes.

When examined in isolation, there were no clear patterns within or between high- and low-responders for vividness of original and new imagery elements. However, when these codes were considered relative to each other, three of the four high-responders' new imagery was rated as more vivid or equally vivid (P2) compared with the original imagery. In contrast, two of the three low-responders' original imagery was more vivid than the new imagery (P3, P7). Original and new internal processes showed similar but clearer patterns. Larger, more stable treatment gains were experienced by those whose original processes were less intense than new processes (P1, P4, P5). Smaller/no treatment gains were experienced by those whose original, trauma-related processes were either minimal/absent (P3, P6) or very intense (P7). Furthermore, original processes for low-responders tended to be rated more intensely than new processes (P6, P7). The other element of interest to note from the SCED observations is that high-responders often progressed to optimal levels of various processes across sessions (e.g. P4 and P5 show increasing GOS).

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Table 3. Patterns of coding within and between high- and low-responders

Observed differences between high- and low-responders		
Code	Patterns for high-responders (P1, P2, P4, P5)	Patterns for low-responders (P3, P6, P7)
GOS	Consistently high simulation levels (P1, P2) or increasing from moderate to high across sessions (P4, P5)	Moderate simulation
Timing of change	Change introduced during the original trauma experience	Change introduced immediately before original trauma (P3, P6) or during the trauma experience (P7)
Therapist guidance	Consistently self-guided (P2, P4) or progression from therapist to self-guided (P5). One had moderate–high levels of therapist-guidance (P1)	Consistently relied on therapist prompting (P3, P6, P7)
Cognitive/emotional shift	Consistently high levels (P1, P2, P5) or progressing to moderate across sessions (P4)	Low (P3) or moderate P6, P7) levels
Rescript believability	Consistently high levels (P1, P2) or progressing to moderate (P4) or high (P5) across sessions (P4)	Low (P3) or moderate P6, P7) levels
No clear observed differences between high- and low-responders		
Code	Patterns for high-responders (P1, P2, P4, P5)	Patterns for low-responders (P3, P6, P7)
Image departure	Some original but mostly new imagery across sessions	Some original but mostly new imagery across sessions (P3, P6) or mostly original trauma-imagery (P7)
Ability to stay with the image	All able to stay with the imagery	All able to stay with the imagery
Original imagery activation	No clear pattern; high levels of activation (P1, P2) or low to moderate levels with some increases across sessions (P4, P5)	No clear pattern; high (P3, P7) or low (P6) activation
New imagery activation	Generally high (P2, P4, P5) or increasing from moderate to high (P1) activation	Moderate (P3, P7) to high activation (P6)
Original processes	No clear pattern; low (P2) or moderate to high (P1) intensity with some increasing across session (P5) and some decreasing (P4)	Absent (P6), low (P3) or high (P7) intensity
New processes	Consistently intense new processes	Low (P3) or moderate (P6, P7) intensity

Descriptive analysis at group level

Descriptive statistics were used to compare codes for high- and low-responders. For participants with more than one rescripting session, summary scores were computed by averaging codes across sessions (summarised in Table 4). Darker shading represents higher ratings. Participants are listed in order of symptom severity change. Mean high-responder and low-responder scores for each code are also presented in Table 4.

All high-responders' rescripts (P1, P2, P4, P5) were rated as well-simulated or 'highly' simulated, while low-responders' rescripts (P3, P6, P7) were in the 'medium' range, suggesting less coherent image descriptions. In terms of session content, the clearest observed difference was for activation of new processes. All high-responders incorporated very intense emotions, cognitions and/or physical sensations within the new, rescripted imagery, while low-responders' new processes were rated as less intense. Apparent differences can also be seen for cognitive/emotional shift, therapist guidance and rescript believability. High-responders appeared to experience higher levels of cognitive/emotional shift and rescript believability, while low-responders appeared to experience lower levels of each. For therapist guidance, low-responders appeared to require more overall guidance than high-responders.

Less pronounced differences were observed for the timing of change in ImRs and new imagery activation. All high-responders incorporated changes during the most aversive scenes of the imagery, while two of the three low-responders chose to imagine changes in the events before

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Table 4. Participant GOS and session content ratings across all ImRs sessions

P	Symptom severity change	GOS	Image departure	Timing of change	Staying with image	Therapist guidance	Original imagery activation	New imagery activation	Original processes	New processes	Cognitive/ emotional shift	Rescript believability
4	44.2	8.7	2	3	3	2.7	1.3	2.7	1.7	2.7	1.7	1.7
2	41.7	12	2	3	3	3	3	3	1	3	3	3
1	39.2	9	2	3	3	2.3	2.7	2.3	2.3	3	2.7	2.7
5	33.3	9	2	3	3	2	1.5	3	1.5	3	3	2.5
3	21.7	7	2	2	3	2	3	2	1	1	1	1
6	10	7	2	2	3	1	1	3	0	2	2	2
7	10	5	1	3	3	2	3	2	3	2	2	2
HR mean		9.68	2	3	3	2.5	2.13	2.75	1.63	2.93	2.6	2.48
LR mean		6.33	1.67	2.33	3	1.67	2.33	2.33	1.33	1.67	1.67	1.67
Bootstrapped *r* with symptom severity change		.83*	.56	.59	—	.82*	.01	.33	.10	.69**	.42	.43
95% CI		.57–.98	.35–.99	.09–.99	—	.56–.99	−.84–.83	−61–.92	−.84–.97	.24–.99	−.46–.97	−.41–.99

High-responders are above the thick horizontal line and low-responders are below. Mean codes for high- and low-responders are represented at the bottom of the table. GOS coding ranges from 0 to 12 and session content codes range from 0 to 3. Darker shading represents higher levels/categories across codes. For GOS, simulation was divided into three levels: 1–4, 5–8, 9–12. *Two-tailed $p < .05$; **one-tailed $p < .05$.

the most aversive scenes. High-responders' new imagery elements also tended to be somewhat more vivid than low-responders'.

There were no pronounced patterns for remaining codes. Although less clear-cut, original imagery activation ratings showed the opposite pattern to new imagery activation, with original imagery elements rated as marginally less vivid for high-responders relative to low-responders. In terms of image departure, all participants but one incorporated some original but mostly new imagery elements. P7, who responded least to ImRs, included some new but mostly original imagery. In terms of processes relating to the original imagery, mean scores for high- and low-responders were similar. However, low-responders' original processes appeared to be either very intense or minimally intense, while high-responders' original processes fell more within the middle range of intensity. All participants were rated as being able to stay with the imagery throughout.

Correlation analysis at group Level

Using bootstrapping, GOS and individual session content codes were correlated with symptom severity change (Table 4). GOS showed the strongest association and was significantly correlated with symptom severity change ($r = .81$, $p < .05$). In terms of session content, two factors, therapist guidance ($r = .82$, $p < .05$) and activation of new processes ($r = .69$, $p < .05$) were significantly correlated with symptom severity change. No other session content codes were significantly correlated with symptom severity.

Discussion

This study employed a SCED design and the use of coding to investigate potential underlying factors contributing to symptom change in ImRs, with a particular focus on the role of mental simulation. In summary, goodness of simulation, therapist guidance and activation of new processes were associated with reductions in symptom severity following ImRs for all forms of analysis. In contrast, the ability to stay with the imagery and image departure showed little or no difference across high- and low-responders in any analysis. While not correlated with magnitude of change, cognitive/emotional shift and rescript believability both appeared to show different patterns for high- and low-responders in group and individual visual analysis. While less pronounced, the timing of change also appeared to differ across responder groups at the level of visual analysis.

Imagery activation and activation of processes were coded for both the original and new imagery. With the exception of new process activation, these codes showed unclear links when considered separately. However, descriptive analyses suggested that participants achieved greater symptom severity reductions when there was a balance in activation between old and new processes whereby new rescripted imagery was at least as vivid as the original imagery and contained new processes at least as strong as the original processes. Furthermore, for activation of original processes, optimal levels of activation appeared to fall in the middle ranges, rather than at the extremes. Individual SCED analysis also suggested that this balance unfolded dynamically across ImRs sessions working on the same image, gradually progressing towards optimal levels across sessions, suggesting an iterative process of refining the rescript's content.

All forms of analysis offer support for the role of goodness of simulation in imagery rescripting. Hence, effective ImRs may rely, in part, on the quality of mental simulation of the imagined events, and the resulting coherence of the rescript. Previous findings suggest that GOS predicts subjective probability (Tversky and Kahneman, 1973) and enhances one's ability to interpret past events and alter their emotional states (Taylor and Schneider, 1989). In line with this, activation of new processes showed the highest correlation with change in symptom

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severity as well as the largest observed mean differences between high- and low-responders. Furthermore, while correlation with symptom severity was not significant, visual analysis suggests clear differences between high-and low-responders for cognitive/emotional shift and rescript believability. Thus, through producing a well-simulated rescript, it may be that high-responders experienced more intense new thoughts, emotions and sensations, a higher level of cognitive/emotional shift and strong levels of belief in the rescript, relative to low-responders, whose rescripts were less well-simulated.

A significant correlation was also found between symptom severity change and therapist guidance, suggesting that low-responders required more overall therapist guidance than high-responders, who tended to rescript more autonomously. However, individual analysis showed that some high-responders progressed from therapist- to self-guided rescripting across sessions. Thus, initial therapist prompting and guidance may facilitate subsequent independent rescripting and associated relief of symptoms. This may suggest that more therapist guidance in early ImRs sessions helped participants acquire skills necessary to generate well-simulated, compelling images, and in striking the balance in activation between old and new processes.

The observational findings in relation to cognitive/emotional shifts during ImRs align with previous work suggesting that generation of new mental imagery may facilitate strong changes in cognition and emotion (Ji *et al.*, 2016; Long and Quevillon, 2009) and inhibit negative arousal associated with original imagery (Rusch *et al.*, 2000). However, it has also been suggested that, in order to be effective, ImRs must also link to the key cognitions and emotions linked with the original event (Wheatley and Hackmann, 2011). In this respect, descriptive group analysis and individual SCED analysis suggested that those who experienced greater changes in intrusive imagery tended to activate both original and new thoughts and emotions. In general, higher levels of activation for new image processes were significantly associated with changes in symptom severity. Observational analysis showed that high-responders also produced moderate to high levels of original processes, while tending to be less intense than for new processes. Whether GOS automatically facilitates the associated thoughts/emotions was not tested. Furthermore, some suggest explicitly focusing on altering the beliefs within the traumatic image (Wilde and Clarke, 2011) or facilitating a more compassionate view of self (Wheatley *et al.*, 2007) during rescripting. While the approaches used in the current study were open to exploring such processes, they were not necessarily explicitly prompted for due to the socratic nature of rescripting used.

Descriptive and observational analyses also suggested better outcomes when new imagery was as vivid or more vivid than the original imagery and when original activation fell in the middle ranges, rather than at the extremes. As a facet of GOS, higher levels of vividness of new imagery was linked to greater reductions in symptom severity. These findings fit with current PTSD theories (Brewin *et al.*, 1996; Brewin *et al.*, 2010; Ehlers and Clark, 2010; Foa *et al.*, 1989; Foa and Rothbaum, 1998) that highlight the necessity of optimally activating the original traumatic memory through imaginal exposure, while at the same time remaining within a 'window of tolerance' (Siegel, 1999). Hence, if the original memory and processes are experienced too strongly, the new ImRs imagery may not be able to effectively compete with the original. Conversely, when the new ImRs imagery was maximally activated and vivid, it appeared more often to 'win out' in terms of symptom reduction.

Clinical implications for effective ImRs

Based on the current, preliminary findings, a possible framework to guide the clinical application of ImRs to PTSD could be as follows. Change seems best facilitated when imagery consists of some original, but mostly new imagery that coincides in time with the original traumatic event (rather than introducing change beforehand). In addition, emphasis should be placed on enhancing the quality of the mental simulation and coherence of the rescript in question. This could encompass

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elements such as logical and temporal sequencing, minimisation of uncertainty, and increasing detail and vividness. That is, patients should be supported to elaborate their rescripts, adding details such that they have a sense of temporal flow, with the scenario unfolding over time, a sense of logical sequencing[2] such that elements of the scenario are logically connected with each step following from the previous one and that the scenario gives a comprehensive account with minimal uncertainty about what is being described.

Focus on a well-simulated rescript that includes both original and new imagery elements may naturally facilitate access to both original and new emotions, thoughts and sensation. This, in turn, may facilitate a sense of plausibility/belief in the rescript as well as a strong shift in cognition/emotion. Ensuring that only some of the original imagery is included may prevent high levels of vividness of original image elements and intense original processes from overwhelming people such that they come out of the imagery or fail to experience a shift in cognition/affect.

In terms of therapist guidance, independent rescripting seems ultimately beneficial, although initial therapist prompting and guidance may be necessary to promote independent rescripting, and this could be viewed as an iterative process of skill acquisition. Thus, in the early stages, therapists may provide explicit guidance to develop rescripts to include those elements described here, reminding clients of omitted elements. Over time, prompts and suggestions should be replaced with Socratic questions as appropriate to help patients to develop their skills in independently using rescripting. The role of the therapist may therefore be viewed as supporting the patient to learn how to become a director of compelling 'mental movies' that effectively 'outsell' the original distressing intrusive imagery. As part of socialisation to the technique, the therapist can explore the kinds of film their patient likes, and what they think makes a great film – storytelling, dialogue, continuity and timing, emotionality, sound effects, cinematic visuals, memorable endings. This frame may offer an accessible way of understanding how to enhance goodness of simulation and refine the skills of rescripting, as well help to identify the particular kinds of rescripts – whether dramatic, comedic or fantastic – that may work best for each individual.

Finally, previous studies have shown high drop-out rates for traditional exposure therapy (Najavits, 2015). One potential contributing factor for this is the difficulty for patients of re-living the original traumatic imagery. Based on the current findings, including a small amount of original imagery that, while vivid, is less vivid than the subsequent rescripted imagery, may support people to connect with and tolerate this process more effectively.

Strengths and limitations

This is the first study to consider ImRs within the GOS framework. The use of SCED and coding to uncover processes at work in ImRs is a further strength. A broad range of factors were encompassed within this study and results highlight those factors that are most likely to be involved in producing clinical change, thus providing important direction for future research. Furthermore, the naturalistic design and setting, and the heterogeneity of the sample increase the external validity of findings.

While the small sample size is a condition for SCED and therefore not a limitation in and of itself, it does reduce the applicability of statistical analyses. Thus formal statistical analysis was supported by descriptive, observational analysis in the current study. It should be acknowledged that SCED studies typically balance small sample sizes with more intensive, repeated measurement and, where possible, multiple phase changes. Due to the nature of the current intervention and endeavours to maintain a naturalistic design without disrupting

[2]Note that 'logical' in this context does not pertain to events that are logically possible within the real world. Many unrealistic events may be logical within the narrative of the story within the rescript (e.g. use of magical powers or appearance of imaginary/dead people).

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routine treatment, pursuing such a strategy was precluded. A further limitation is that coding was based on session recordings. However, it is likely that further practice between sessions may have enhanced factors such as simulation. Monitoring between-session practice and recording a final version of participant rescripts at follow-up for coding purposes would have been beneficial. Finally, while external validity was a strength of this study, with the open approach to ImRs allowing for coding of a broad range of rescripting techniques, this approach makes it difficult to speak to the strengths and weaknesses of one rescripting protocol over another. Rather, this study provides preliminary findings for the role of general ImRs elements (e.g. GOS). Future studies may benefit from looking at mechanisms of change within specific ImRs protocols.

Conclusions

This study provides preliminary, yet promising, support for the role of goodness of simulation in understanding ImRs efficacy. It also provides some evidence of links between conceptual 'top-down' processes and observable 'bottom-up' ImRs factors such as the activation of new processes, cognitive/emotional shift and believability in the rescript. Thus, GOS may provide a useful framework to guide clinicians when planning and implementing ImRs therapy with clients. It may also provide a useful metaphor to explaining the rescripting process to clients. The field would benefit from further research into the hypothetical links between GOS and session content codes, to identify whether these contribute independently to outcome, whether factors such as emotional/cognitive processes and rescript believability are dependent on GOS, or vice versa. This may contribute to developing a data-driven model of the cognitive processes underlying ImRs, as well as novel directions for basic process research into imagery.

Supplementary material. To view supplementary material for this article, please visit: https://doi.org/10.1017/S1352465820000806

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