Journal of Anxiety Disorders

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--Manuscript Draft--

Manuscript Number:	ANXDIS_2019_255R1
Article Type:	Research Paper
Keywords:	Social anxiety; autobiographical memory; imagery rescripting; imaginal exposure; supportive counselling
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Abstract:	Imagery rescripting (IR) is an effective intervention for social anxiety disorder (SAD) that targets negative autobiographical memories. IR has been theorized to work through various memory mechanisms, including modifying the content of negative memory representations, changing memory appraisals, and improving negative schema or core beliefs about self and others. However, no prior studies have investigated the unique effects of rescripting itself relative to other IR intervention components on these proposed mechanisms. Thirty-three individuals with SAD were randomized to receive a single session of IR, imaginal exposure (IE), or supportive counselling (SC). Memory outcomes were assessed at 1- and 2-weeks post-intervention and at 3-months follow-up. Results demonstrated that the content of participants' autobiographical memory representations changed in distinct ways across the three conditions, such that IR facilitated increases only in positive/neutral memory details, but IE facilitated increases in both positive/neutral and negative memory details and SC facilitated no changes in memory details. Although memory appraisals did not differ across conditions, participants who received IR were more likely to update their negative memory-derived core beliefs. These unique effects of rescripting on memory representations and core beliefs enhance our understanding of the memory-based mechanisms of IR within the context of exposure-based learning for people with SAD.

Highlights

- Examined effects of imagery rescripting (IR) on memory outcomes in social anxiety disorder
- IR was compared to imaginal exposure (IE) and supportive counselling
- IR led to increases in positive memory details over time
- IE led to increases in both positive and negative memory details
- IR also facilitated the expression of updated core beliefs

The Effects of Imagery Rescripting on Memory Outcomes in Social Anxiety Disorder

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Abstract

Imagery rescripting (IR) is an effective intervention for social anxiety disorder (SAD) that targets negative autobiographical memories. IR has been theorized to work through various memory mechanisms, including modifying the content of negative memory representations, changing memory appraisals, and improving negative schema or core beliefs about self and others. However, no prior studies have investigated the unique effects of rescripting itself relative to other IR intervention components on these proposed mechanisms. In this preliminary study, 33 individuals with SAD were randomized to receive a single session of IR, imaginal exposure (IE), or supportive counselling (SC). Memory outcomes were assessed at 1- and 2-weeks post-intervention and at 3-months follow-up. Results demonstrated that the content of participants' autobiographical memory representations changed in distinct ways across the three conditions, such that IR facilitated increases only in positive/neutral memory details, but IE facilitated increases in both positive/neutral and negative memory details and SC facilitated no changes in memory details. Although memory appraisals did not differ across conditions, participants who received IR were more likely to update their negative memory-derived core beliefs. These unique effects of rescripting on memory representations and core beliefs enhance our understanding of the memory-based mechanisms of IR within the context of exposure-based learning for people with SAD.

Keywords: social anxiety; imagery rescripting; imaginal exposure; supportive counselling; autobiographical memory

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1. Introduction

Cognitive models of social anxiety disorder (SAD) posit that negative self-imagery is central to the maintenance of the disorder (Clark & Wells, 1995; Rapee & Heimberg, 1997). Negative self-images often originate as a result of significant, socially painful autobiographical experiences (Hackmann, Clark, & McManus, 2000; Moscovitch et al., 2018), tying them thematically to negative core beliefs derived from these earlier 'social failures' (Cili & Stopa, 2015). Persistent experiences of negatively distorted self-imagery may therefore prevent socially anxious individuals from updating negative schema in the face of disconfirming evidence (Hirsch, Clark, & Mathews, 2006; Ng, Abbott, & Hunt, 2014; Wild & Clark, 2011). As such, therapeutic interventions that work by harnessing these affectively-charged memory-derived images may be particularly fruitful for targeting social anxiety symptoms (e.g., Iyadurai et al., 2018; McEvoy, Erceg-Hurn, Saulsman, & Thibodeau, 2015).

Imagery rescripting (IR) is a therapeutic technique that aims to modify negative mental self-representations (Holmes, Artnz, & Smucker, 2007; Morina, Lancee, & Arntz, 2017). In IR, which can be delivered within a single therapy session during the course of CBT, patients are guided to re-imagine past negative experiences in order to meet the needs of the younger self within the memory (Arntz, 2012; Arntz & Weertman, 1999). Patients' "rescripting" of the memory typically involves actively imagining and guiding their younger selves to behave in ways they wished they could have at the time of the event, or having their older selves protect, nurture, or stand up for their younger selves in their moments of need. These interventions aim to make the event more positive or satisfying for the younger self such that new information is incorporated into the scene that can help to change the meaning of the memory. For example, by

having the younger self stand-up to a critical other or receive compassion from the older self, the patient may observe that they did not deserve the harsh treatment they received at the time. By allowing the patient to change the memory in any way that they feel is right, IR can induce new perspectives on what happened at the time of the event (Arntz, 2011; Edwards, 2007).

Prior research has shown that IR delivered as a brief stand-alone intervention over the course of one or more sessions, either with or without cognitive restructuring, reduces social anxiety symptoms as well as the emotional impact and salience of negative autobiographical memories and associated memory-derived negative core beliefs (e.g., Frets, Kevenaar, & van der Heiden, 2014; Lee & Kwon, 2013; Nilsson, Lundh, & Viborg, 2012; Norton & Abbott, 2016; Reimer & Moscovitch, 2015; Wild, Hackmann, & Clark, 2007, 2008). Though still empirically untested, a number of hypotheses have been proposed to account for the effects of IR, which correspond with differing views on what happens to the episodic memory itself as a result of treatment. Arntz has suggested that IR may modify the fear memory directly so that it becomes reconsolidated with a different meaning (Arntz, 2011; Arntz & Weertman, 1999). This account does not imply that IR erases the original memory representation, but rather that the *meaning* of the experience – particularly the automatic emotional processes associated with the memory – changes such that the original emotional memory no longer elicits the original emotional response. It is also possible that IR creates an alternative memory (or schema) that competes with the original for preferential retrieval (e.g., Brewin, 2006; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014).

At present, it is unknown whether the actual content of the rescripted autobiographical memory changes as a result of IR, or whether it is only its appraised meaning that changes. If memory content and/or meaning change during IR, is rescripting primarily responsible for this,

or could similar changes occur by processing the memory in other ways, without explicit attempts to modify or rescript the memory itself? For example, imaginal exposure (IE) guides patients to relive a traumatic event repeatedly or over a prolonged period of time in as much sensory and emotional detail as possible (Foa & Rothbaum, 1998). Doing so is thought to facilitate emotional processing by activating the fear memory and enabling corrective information to be incorporated (Foa & Kozak, 1985, 1986; Lang, 1977). Research on IE for PTSD has shown that it promotes habituation to the fear response associated with the memory, reappraisal of the memory, and generation of a more coherent memory narrative (Foa, 2011; Foa & Cahill, 2001). Given that there are a number of similarities between Criterion A traumatic events and the socially painful or traumatic experiences described by socially anxious individuals (Carleton, Peluso, Collimore, & Asmundson, 2011; Erwin, Heimberg, Marx, & Franklin, 2006), IE may be similarly effective for modifying negative memories in SAD even in the absence of explicit rescripting (see Foa, Huppert, & Cahill, 2006).

The current study aimed to isolate the unique effects of rescripting on memory outcomes by examining the effects of single-session IR alongside two single session control conditions: (a) IE, in which patients were exposed deliberately and repeatedly to the negative memory content in their imagination without rescripting, and (b) supportive counselling (SC), in which patients were exposed to non-specific therapeutic components without repeated exposure to the memory narrative or rescripting. Though these brief interventions represent standalone protocols, they are best conceptualized as components of therapy rather than comprehensive treatments. As the modification of memory is thought to be central to the salutary benefits of IR, we were particularly interested in examining intervention-related changes in memory content, memory appraisals, and memory-derived schema (core beliefs). Given the relative brevity of the

interventions and small sample size, we have conceptualized the present study as a preliminary investigation that would require replication and extension in future research.

We advanced several specific hypotheses. First, given that IR explicitly aims to rescript the content of episodic memory representations, we predicted that the content of participants' autobiographical memory narratives would change uniquely in the IR condition such that positive and neutral memory details would increase over time, but that such enhancements in positive and neutral details would not occur in the other two conditions. Second, we anticipated that rescripting would facilitate significant changes in memory appraisals. Because Arntz has suggested that changes in meaning may be represented by changes in automatic emotional processes associated with the memory (Arntz, 2011; Arntz & Weertman, 1999), we operationalized memory appraisals as the amount of negative affect experienced upon memory retrieval as well as subjective ratings of memory intrusiveness and vividness. We expected that negative affect, intrusiveness, and vividness would decrease significantly over time for IR participants. Further, we expected that similar changes in memory appraisals would occur for those in the IE condition due to the effects of repeated imaginal exposure to the memory, but not for those in the SC condition in the absence of rescripting or exposure. Third, since IR is designed to facilitate new perspectives on the event, we hypothesized that rescripting would promote significant updating of participants' negative core beliefs about the self and others, whereas the same would not be true of either IE or SC.

2. Method

2.1 Participants

The study sample consisted of 33 community participants who met DSM-5 (American Psychiatric Association, 2013) criteria for a current principal DSM-5 diagnosis of SAD.

Diagnoses were based on the administration of the *Mini International Neuropsychiatric Interview* 7.0 (MINI-7.0; Sheehan, 2014) and sections of the *Anxiety Disorders Interview Schedule for DSM-5* (ADIS-5; Brown & Barlow, 2014) by trained graduate students. Exclusion criteria included endorsement of active and clinically significant suicidality, mania, psychosis, or substance abuse/dependence. Concurrent pharmacotherapy was allowed, provided that medication dosage had been consistent for three months and participants intended it to remain stable during the course of the study[1]. Recruitment and assessment methods are described in more detail in the Supplementary Materials.

2.2 Procedure

The full study procedure is presented in Figure 1. Diagnostically eligible participants who could identify a negative social memory that occurred at a specific time and place (i.e., a true autobiographical memory; Tulving, 1989) were randomized with sex and gender stratification to one of the three conditions using an electronically generated allocation sequence. During a pre-intervention session (session 1), participants completed measures to ensure symptom equivalence between conditions at baseline (see Supplementary Materials). Participants then completed a structured memory interview (WIMI), which generated memory narratives for later content-coding, as well as associated ratings of memory appraisals. One week following the first session, participants received their assigned intervention and completed ratings of memory-derived core beliefs, treatment alliance, and credibility (session 2). Both one and two weeks following the intervention session, participants returned for two post-intervention assessment sessions (session 3 and 4), which consisted of re-administration of the WIMI and measures of memory appraisals.

[1]Only one participant reported taking benzodiazepine medication, which has the potential to interfere with fear activation during exposure (Foa & Kozak, 1986; Otto, McHugh, & Kantak, 2010). Analyses were conducted with and without this participant and the overall pattern of results and effect sizes were the same, with only minor fluctuations in p values. Thus, the analyses presented contain all participants unless otherwise noted.

At the conclusion of session 3, participants were also assigned daily intervention-related homework (described below), which was discussed in session 4. Follow-up assessments of memory content and appraisals occurred during the fifth session, three months following the intervention session. All study procedures were approved by the institutional ethics board.

2.3 Semi-structured interviews

Waterloo Images and Memories Interview (WIMI; Moscovitch et al., 2011). Using the WIMI, the experimenter guided participants to describe any mental image they typically experience in social anxiety provoking situations, and whether they recall experiencing any particular event at a specific time and place that they believe was related to that mental image.

Core Beliefs Module for the WIMI (Reimer & Moscovitch, 2015). This module was used to identify any important personal meaning encapsulated within participants' endorsed memories. Specifically, the experimenter employed the downward arrow technique to uncover what the memory represents to participants about themselves, others, and the world; participants were asked to identify one belief for each category[2]. Analyses focused only on beliefs about self and others, which may be particularly relevant to central cognitive themes in SAD (e.g., Moscovitch et al., 2011; 2018).

2.4 Interventions

Overview of interventions. Each intervention consisted of one 60-90 minute session (M = 69.12 minutes, SD = 17.82), administered according to a standardized protocol by a postdoctoral researcher in clinical psychology (author MR) who received training and supervision by authors DM, JH, and SGR. The intervention session included a description of a treatment rationale, a

[2]Although participants may have identified multiple core beliefs for each category, for study purposes they were asked to select one belief from each category that felt most important or relevant to their construed meaning of the memory.

brief recap of the negative memory derived from the WIMI, administration of the intervention technique, and an open-ended exploration in which participants were given an opportunity to reflect on their experience of the intervention and update memory-derived core beliefs. In IR and IE, participants were encouraged to close their eyes and assume a comfortable position for the imagery procedures, which focused on the specific negative memory derived from the initial WIMI interview. The imagery procedures in both conditions tended to last for about 60 minutes.

IR. The IR protocol involved three phases, as per published guidelines from prior research (Arntz & Weertman, 1999; Wild et al., 2007, 2008), and did not include cognitive restructuring. In phase one, participants recounted the memory from their own point of view at the time of the event (i.e., the "younger self"), describing the sequence of events using the first person and conveying as much detail as possible, including characteristics of the environment, others present, and their own feelings and thoughts. In phase two, participants were instructed to observe the sequence of events occurring to the younger self from the perspective of their current self, as if they were witnessing it as a bystander would. Participants were then encouraged to modify the scene in their imagination, doing whatever they wished to make the outcome of the event "more positive or satisfying" for the younger self. In phase three, as in phase one, participants relived the memory from the perspective of the younger self but this time incorporating the new content from phase two, and enacting any further changes in the scene until they achieved a sense of completion.

IE. The IE protocol was adapted for SAD-relevant social memories based on typical protocols of PE for PTSD (Foa, Hembree, & Rothbaum, 2007). During the intervention, participants were asked to imagine the entire memory scene vividly and relive the memory from their own point of view at the time of the event. Participants were guided to describe the images

to the therapist using the first person, conveying as much detail about the sequence of events as they could recall; they were encouraged to focus on and experience all sensory details and emotions accompanying the imagined event. The image and associated emotions were intensified by asking participants to concentrate on the sensory details or the hotspot of the event (e.g., the most embarrassing part of the memory). To mirror the three phases of the IR condition, the participants repeated this same process of reliving the scene three times in a present-focused, emotionally-immersive fashion. There were no prescribed time requirements for each phase, but phases 2 and 3 of reliving in IE tended to last longer than the first phase. Perhaps this was because participants became more comfortable with the process and were willing to elaborate more on the memory details.

SC. The SC protocol involved an unstructured discussion of the participants' experience of negative images and memories. The rationale provided for the intervention was that talking about images and memories may help them gain insight into the role they play in their current experience of social anxiety. SC sessions were non-directive; however, the protocol provided example questions and themes the therapist could opt to explore with patients, such as: "*How do negative images affect your everyday life*," "*How do the images make you feel and/or behave*," "*When these negative images come to mind how do you typically cope with them.*" SC participants received active listening, empathy, and support for the negative experiences they chose to discuss, but participants were never offered directive advice or CBT skills. The discussion in the SC intervention was sustained for at least 60 minutes (the minimum length of IR/IE sessions).

2.5 Homework

In order to mirror real-world clinical settings, particularly for IE, in which patients typically listen to their imaginal exposures for homework in order to enhance the effects of the intervention (Cooper, et al., 2017), participants were assigned daily homework according to the intervention they each received, to be completed between post-intervention sessions 3 and 4. In homework for IR, participants were encouraged to recollect the rescripted version of their memory and to recall their updated beliefs whenever they encountered anxiety-provoking situations during the week. Participants who received IE were instructed to listen to the audio recording of their imaginal exposure. In SC, participants were asked to reflect on their experience during the SC session. Homework adherence was assessed by counting the number of times participants completed the assigned homework out of a possible six days.

2.6 Measures

Ratings of intervention fidelity, alliance, and credibility. All intervention sessions were video recorded and an independent graduate student blind to condition rated a randomly selected 10% of sessions on protocol adherence (see Supplementary Materials for the protocol as based on Kunze, Arntz, Morina, Kindt, and Lancee, 2017). Participants also completed the Session Rating Scale (SRS; Duncan et al., 2003), a measure of therapeutic alliance on which they rated the degree to which the session met their needs in terms of four qualities (therapeutic relationship, goals and tasks, therapist approach, and overall fit of the session), yielding a total score on a 0-40 scale, with higher scores indicating stronger ratings of therapeutic alliance (α = .93). Finally, participants responded to three items addressing their perception of treatment credibility on a scale from 1 (not at all useful) to 9 (very useful) (α = .83; Devilly & Borkovec, 2000).

2.6.1 Memory content

WIMI narratives. To assess for changes in the content of the memory representation over time, the WIMI was audiotaped, transcribed, and coded by trained research assistants who were blind to the diagnostic status and intervention condition of participants. Coded memory narratives were analyzed at sessions 1, 3, and 4 and at the 3-month follow-up session.

Each WIMI memory narrative was coded based on the standardized system of the Autobiographical Interview (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; see also Moscovitch et al., 2011; 2018). After identifying the "main event" in the narrative, coders divided narratives into individual details representing separate utterances or grammatical clauses, and coded each detail as being either "internal" or "external." Internal details represented episodic details pertaining to the main event that occurred at a specific time and place, while external details represented non-episodic details (i.e., semantic knowledge not connected to the specific event or details pertaining to an event other than the target event). Coders then identified the valence of each internal and external detail as positive, negative, or neutral. In the current study, we were interested in analyzing the presence and modification of internal details specifically, as these reflect the episodic richness of an autobiographical memory (see Moscovitch et al., 2018). The presence of positive details in participants' negative memory narratives was very rare; therefore, positive details were combined with neutral details for analyses.

Coder training and reliability. Four research assistants were trained by an expert coder in line with the methodology used in Moscovitch et al. (2011, 2018). Following the training phase, coders were randomly assigned to participant narratives such that each coder coded one narrative per participant (of a possible four narratives across time) and also such that all coders completed a roughly equivalent number of narratives per session and overall. To minimize

potential coder drift, author MR double-checked a random subset of each coder's coded narratives for accuracy and provided feedback, as appropriate. A randomly selected sample of narratives (15%) from the total pool of coded narratives (n = 127) were also double coded by each coder. ICCs (absolute agreement; two-way mixed model) were .90, .89 and .91 for total internal details, negative and positive/neutral details, respectively.

For further information about WIMI procedures, see Supplementary Materials.

2.6.2 Memory appraisals

Subjective ratings. Immediately after the WIMI interview administration at each session, participants rated perceived memory vividness (*While envisioning/remembering the event, I could see it clearly in my mind*) and memory intrusiveness (*This memory has previously come to me out of the blue, without my trying to bring it to mind*) on scales from 1 (not at all) to 5 (extremely). Participants also rated the emotional impact of retrieving the memory on 10 emotion adjectives from the negative subscale of the *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988), with instructions modified to ask about feelings when remembering the event in question. The 10 negative affect adjectives were sum-scored for analyses, with good to excellent internal consistency across time points (α = .83-.92).

Core beliefs: updating. At the end of each intervention session, participants had the opportunity to update their reported original beliefs about self and others derived from the negative memory in any way they desired. Specifically, participants were instructed to reflect on what they learned during the intervention and, on this basis, to consider whether they would alter or revise their original beliefs. Participants first responded to a categorical item (yes/no): "*Do you have an updated core belief about the self (others)*?" Then, they recorded the updated belief as they wished. Following the procedure of Reimer and Moscovitch (2015), a belief was

considered to be "updated" if the new belief represented a more positive or realistic reframe of the original negative core belief. For example, the original core belief "I am unlovable," which was endorsed by more than one participant, was updated to: "I know I am lovable," or "I see unloveability as situational now rather than inevitable; when I am with my family – my husband, kids, and chosen family – I know that I am loved and lovable."

2.7 Data analytic procedures

Data screening. Supplementary Materials contain information about how outliers and variables with distribution problems were handled.

Outcome analyses. All randomized participants who received an intervention were included in the analyses, irrespective of whether or not they completed all sessions. Of the total sample, 91% completed all lab sessions. Of these participants, four had excluded data points (described in Supplementary Materials). The numbers of participants analyzed at each post-intervention session are presented in Figure 1.

Chi-square tests, reporting the Fisher's Exact test statistic, were used to examine differences in the proportion of participants between conditions whose core beliefs were updated after the intervention session. The relative likelihood of core belief updating across conditions (i.e., risk ratio: RR) was calculated as a measure of effect size for the chi square analyses. RR values of 1.00 represent identical likelihood across conditions, and values < 0.5 or > 2.00 represent a clinically significant difference in likelihood between conditions (Andrade, 2015).

Linear mixed-effects models (LMM) were used to examine outcomes within conditions across time. The LMM approach permits non-independence of observations and examination of fixed effects (e.g., time, condition, and condition by time) that are not confounded by between-subject variability in intercepts and slopes. Additionally, LMM is robust to missing data and

small samples when examining fixed effects of time, even in the presence of high between-subject variability (Pietrzak, Fredickson, Snyder, & Maruff, 2010). Separate models that included a random intercept[3] were conducted in SPSS for each outcome (WIMI internal details and memory appraisals), with intervention condition (IR entered as the reference condition) and time as fixed factors, and participant as a random factor. Time was modelled continuously, including four time points (pre-intervention baseline, sessions 3 and 4, and 3-month follow-up), and centered at session 1 (baseline). Cohen's *d* (1998) effect sizes at each time point were computed from LMM estimated means and observed standard deviations. Within-condition change was defined as $d = (M_{pre} - M_i)/SD_{pooled\text{-}pre}$, where $SD_{pooled\text{-}pre} = \sqrt{[(SD^2_{preIR} + SD^2_{preIE} + SD^2_{preSC})/3]}$. Estimated marginal means and within condition effect sizes derived from all LMM analyses are presented in Table 2. Post-hoc power analyses using GLIMMPSE (Kreidler et al., 2013) yielded adequate power to detect within-condition changes over time for each variable considered (i.e., estimated power of .90 and above). Thus, our focus was on within-condition effects. Small, medium, and large effect sizes are represented by *d* values of 0.2, 0.5, and 0.8, respectively.

3. Results

3.1 Preliminary analyses

Participant demographic and pre-intervention clinical and memory characteristics are presented in Table 1 and Supplementary Materials (Table S1). Groups did not differ on any measured characteristics at baseline, except for the total number of WIMI internal positive/neutral details. Bonferroni adjusted post-hoc comparisons revealed an unexpected significant difference between the IR and SC conditions, such that IR participants reported more

[3]Details regarding model specification are provided in the Supplementary Materials.

internal positive/neutral details (M = 27.91, SD = 13.90) than SC participants at baseline (M = 13.55, SD = 7.76), p = .009, d = 1.28, 95% CI [0.36, 2.19]. Thus, session 1 positive/neutral details were entered as a covariate (grand mean centered) in LMM analyses pertaining to change in positive/neutral details over time.

3.2 Comparability of intervention sessions

As described in the Supplementary Materials, therapist intervention adherence did not differ across interventions, and neither did participant ratings of intervention credibility ($F_{(2,30)}$ = 2.49, p = .100), or ratings of therapeutic alliance (Welch's $F_{(2,18.15)}$ = 3.20, p = .064). Additionally, participants across conditions did not differ in their amount of homework completion (Welch's $F_{(2,19.29)}$ = 0.60, p = .560).

3.4 Outcome analyses

Changes in memory content. In the model predicting internal negative details, the results demonstrated non-significant effects for both time, $F_{(1,91.06)}$ = 0.73, p = .396, and condition, $F_{(2, 49.63)}$ = 0.35, p = .708; these results, however, were qualified by a significant time x condition interaction, $F_{(2, 91.06)}$ = 3.17, p = .047. With IR entered as the reference condition, parameter estimates demonstrated no difference between IR and either the SC condition (b = -1.19, t = -0.87, p = .389), or the IE condition (b = 2.24, t = 1.62, p = .109), which indicated that the significant interaction effect occurred between the IE and SC conditions. In order to examine this effect, IE was entered as the reference condition. Here the parameter estimate for time was significant, demonstrating an increase in negative details over time (b = 2.37, t = 2.41, p = .018) and a significant time x condition interaction comparing IE to SC (b = -3.43, t = -2.48, p = .015). Inspection of within-subjects changes and effect sizes in each condition (Table 2; Figure 2) indicated that whereas IR and SC were associated with small and non-significant changes in

negative internal details over time from baseline to 3-month follow up, IE was associated with significant and large increases in negative internal details over time.

In the model predicting internal positive/neutral details, the results demonstrated a significant main effect of time, $F_{(1, 91.35)} = 9.04$, $p = .003$, a significant effect of baseline positive/neutral details, $F_{(1, 29.157)} = 9.12$, $p = .005$, and a non-significant effect of condition, $F_{(2, 46.08)} = 0.14$, $p = .872$. These were qualified by a significant time x condition interaction, $F_{(2, 91.32)} = 3.71$, $p = .028$. The parameter estimates demonstrated that positive/neutral details significantly increased over time for IR (time, $b = 5.10$, $t = 2.35$, $p = .021$), an increase that was marginally significant in comparison to SC (time x condition, $b = -6.01$, $t = -1.96$, $p = .053$), but did not differ significantly from IE (time x condition, $b = 2.05$, $t = 0.67$, $p = .508$). When IE was entered as the reference condition, the parameter estimate for time was significant, indicating an increase in positive/neutral details over time ($b = 7.15$, $t = 3.26$, $p = .002$), and the time x condition interaction comparing IE to SC was also significant ($b = -8.06$, $t = -2.62$, $p = .010$). Examination of the within-subject changes and effect sizes (Table 2; Figure 2) showed that for the IE and IR groups, positive/neutral internal details tended to increase over time, with large and significant changes in such details within each of these two conditions from pre-treatment baseline; in contrast, they remained relatively stable for the SC group, with negligible changes across time.

Changes in subjective memory appraisals. For all conditions, negative affect associated with recalling the memory decreased over time, $F_{(1, 89.93)} = 53.73$, $p = <.001$, $b = -3.64$, $t = 5.40$); however, both the effect of condition, ($F_{(2,49.01)} = 2.35$, $p = .106$) and the time x condition interaction ($F_{(2, 89.93)} = 2.24$, $p = .112$) were non-significant. Similarly, memory intrusiveness and vividness decreased over time for each condition, but the effect of condition and the interaction were not significant: Intrusiveness: time, $F_{(1,90.78)} = 37.05$, $p <.001$, $b = -0.31$, $t = -3.34$;

condition, $F_{(2,42.45)} = 1.84$, $p = .171$; time x condition, $F_{(2,90.77)} = 0.03$, $p = .970$; Vividness: time, $F_{(1,91.28)} = 15.52$, $p < .001$, $b = 0.31$, $t = -3.15$; condition, $F_{(2,54.81)} = 0.54$, $p = .586$; time x condition, $F_{(2,91.28)} = 1.03$, $p = .362$.

Changes in content of core beliefs derived from the recalled event. Before receiving their assigned intervention, 100% of the 33 participants identified a negative core belief about themselves that derived from the event and 97% identified a negative core belief about others. After the intervention was complete at session 2, 10/11 (90.9%) and 9/10 (90%) participants in the IR condition revised their core beliefs about self and others, respectively. In IE, 6/11 (54.5%) revised their core beliefs about self and 6/11 (54.5%) revised their core beliefs about others. In SC, 4/11 (36.4%) and 5/11 (45.5%), revised their belief about self and others, respectively. There was a significant difference between conditions in the proportion of participants who updated their core beliefs about the self, Fisher's Exact Test = 7.160, $p = .044$. Follow-up tests partitioning two groups at a time revealed that IR participants were more likely to update their core belief about self than were SC participants ($p = .024$; RR = 2.5, $p = .026$, 95% CI [1.12, 5.59]), but there was no difference between IE and SC ($p = .670$; RR = 1.5, $p = .403$, 95% CI [0.58, 3.88]), or between IR and IE ($p = .074$; RR = 1.67, $p = .080$, 95% CI [0.94, 2.95]). There were no significant differences in the proportion of participants between conditions who updated their core beliefs about others, Fisher's Exact Test = 4.916, $p = .085$.

4. Discussion

By randomly assigning participants with SAD to receive a single session of IR, IE, or SC, the present study was designed to advance our understanding of the effects of rescripting on memory outcomes, including representations of memory content, subjective memory appraisals, and memory-derived core beliefs.

4.1 Effects of condition on memory content

In support of our first hypothesis, findings indicated that negative and positive memory details can each change independently of one another in ways that are consistent with the specific therapeutic technique employed. Specifically, IR facilitated significant increases in positive/neutral but not negative details, while IE generated increases in both positive/neutral and negative details, and SC did not promote changes in either type of detail. Thus, in contrast to SC, which did not target specific memories directly, IR and IE appear to represent distinct ways to modify memory content, each with a unique mnemonic signature.

The fact that IE led to increases in negative episodic memory details is consistent with its explicit focus on repeated exposure to negative memory content for the purpose of processing that content in as much detail as possible, without modification or avoidance. The fact that both IR and IE promoted significant increases in positive/neutral details over time suggests that both interventions may help individuals incorporate new information into patients' memories, even without explicit instruction to do so by the therapist (as in IE). As discussed below, the incorporation of such information into memory may be a reflection of "new learning," which has long been inferred as a central mechanism of effective CBT but one that can be difficult to measure directly.

4.2 Effects of condition on memory appraisals

Consistent with our hypotheses, IR led to significant changes in memory appraisals, such that the intrusiveness, vividness, and negative affect associated with the memory decreased significantly over time. As expected, the same was true of IE, though effect sizes for memory vividness and negative affect during memory recall were more moderate. Unexpectedly, however, similar changes were observed in the SC condition, perhaps due to repeated exposure

to the WIMI interview throughout the study. The WIMI administration requires participants to describe the memory and all associated details, which may have provided SC participants an avenue for emotionally processing the memory, leading in turn to decreases in the salience of the memory.

4.3 Effects of condition on core belief updating

In partial support of our third hypothesis, IR participants were approximately 2.5 times more likely to update core beliefs about the self than those in SC (a significant effect), but only 1.67 times more likely than IE participants (a comparison that did not reach significance). A similar pattern of results was observed for core beliefs about others, though the omnibus test only approached significance. Since negative self-imagery in SAD tends to reflect symbolic personal meaning (Cili & Stopa, 2015), these results suggest that such meaning can shift in accordance with rescripting, which explicitly targets changes in image representation. This finding lends support to IR as a particularly effective intervention for challenging and modifying negative self-schema (Arntz, 2012; Arntz & Weertman, 1999; Stopa, 2009). Although IE participants were not more likely than those in SC to update core beliefs about the self, they also did not differ significantly from those in the IR condition, though the proportion of updated beliefs trended toward a lower rate of updating than in IR. Nonetheless, a possible interpretation of the nonsignificant difference in updating between the IR and IE conditions is that IE might also represent a useful vehicle for core belief change. It would be important to further test this hypothesis with a larger sample in future research.

4.4 Implications of findings for understanding intervention mechanisms

What are the underlying cognitive processes that are responsible for the observed changes in memory outcomes across interventions? Proponents of memory reconsolidation models (e.g.,

Beckers & Kindt, 2017; Ecker, 2015; Lane, Ryan, Nadel, & Greenberg, 2015) might posit that the reactivation of participants' emotional memories during imaginal reliving makes them malleable to subsequent reformulation in ways that are consistent with the specific therapeutic approach. For example, whereas IR encourages patients to reappraise the meaning of the memory by adopting new (and often more positive) perspectives and outcomes, IE encourages them to elaborate and confront the most negative details without avoidance, and indeed the changes observed in memory content tended to mirror these distinct therapeutic aims.

An alternative and potentially complementary perspective is that changes in memory outcomes across conditions were facilitated by a violation of expectancies, which has been shown to promote new learning through the mechanism of prediction error (Fernandez, Pedreira, & Boccia, 2017; Huppert, Fradkin, & Cahill, in press). To this end, a key tenet of emotional processing theory is that repeated imaginal exposure to a painful memory facilitates the incorporation of corrective information into the memory, which may include new information about safety (e.g., feelings of comfort elicited by the presence of therapist), forgotten or previously unattended to details, or evidence that disconfirms the original fear representation (Brewin & Holmes, 2003; Foa & Rothbaum, 1998). This perspective is not inconsistent with that of inhibitory learning and competition retrieval models (e.g., Brewin, 2006; Craske et al., 2014), which focus on the emergence and enhanced accessibility of new mental representations that are incompatible with the meaning of the original representation and therefore compete with (and/or inhibit) the original during instances of subsequent retrieval.

Our study cannot speak to whether or not these new representations are in fact retrieved over time, but the possible clinical benefit of increasing positive episodic details is that they may provide patients with more positive or realistic information upon which to draw when they

encounter anxiety provoking events. More accessible positive details could enable patients to challenge initial negative interpretations more effectively as they arise, to interpret new or novel social situations in a more positive or less threatening manner, and to reduce anticipatory anxiety when planning for future social encounters via the process of mental simulation, which relies on the episodic memory system (Szpunar, Addis, McLelland, & Schacter, 2013).

4.5 Limitations, Future Directions, and Conclusions

Although analyses were adequately powered to detect within-condition effects over time, between-condition effects should be interpreted in light of the small sample size and limited power to detect small effects between the intervention conditions. Furthermore, important unmeasured variables may have been critical to the effectiveness of the intervention with respect to memory outcomes; for example, patients with better imagery ability may benefit most from imagery-based interventions (McEvoy et al., 2015), but we did not assess these abilities in the current study.

We also did not require participants to endorse a "formative" memory; although our methodology resembled that used in prior studies of IR (e.g., Wild et al., 2008), the memory that participants selected may have influenced the success of the imagery-based interventions and it is possible that participants had other important memories that would have also benefited from rescripting or exposure. Similarly, we asked participants to identify only one core belief for each category and it is possible that there were a number of core beliefs tied to the event that were of importance. Finally, while our results suggest that IR may help people to reframe or revise memory-derived negative core beliefs, further research should clarify the extent to which this is reflective of actual changes in underlying schema, which have been traditionally conceptualized

as being persistent and unamenable to rapid modification (Beck, Emery, & Greenberg, 2005; see also Gilboa & Marlatte, 2017).

Although IR was administered in a manner that was identical to its administration in prior research, the administration of IE differed from its typical administration in the treatment of PTSD, where it is commonly repeated over multiple sessions and combined with *in vivo* exposures (Foa et al., 2007) or with cognitive restructuring (Bryant, Moulds, Guthrie, Dang, & Nixon, 2003) to maximize its effectiveness. Although our study design dictated that the single session dose of each intervention was equivalent across conditions, it is possible that administrations of IE in its typical form could lead to different results with respect to memory outcomes, as would be consistent with inhibitory learning and emotional processing theories of IE. For example, it is possible that with larger doses of IE, increases in negative episodic details may subside, and larger changes in negative affect and memory vividness could occur. Furthermore, beliefs about self might also change more (see Cooper, Clifton, & Feeny, 2017).

Future research could also determine the optimal administration of IE for SAD; for example, it may be beneficial to incorporate repeated imaginal exposures to envisioned *future* humiliating or social anxiety provoking scenes in which patients intentionally imagine being rejected or criticized. These imagined scenarios could be embellished to include patients' catastrophic social fears, even in ways that are highly exaggerated (Huppert, Roth, & Foa, 2003), in order to help reduce their sensitivity to rejection while providing opportunities for insights about self and others that facilitate reappraisal of the likelihood and cost estimates of such outcomes (e.g., Moscovitch, Waechter, Bielak, Rowa, & McCabe, 2015). Imaginal exposures to future feared situations could be employed as a therapeutic technique to prepare patients for actual in-vivo exposures. They could also be used as a complementary tool that enables

clinicians to incorporate feared elements into a standardized script that may be difficult to arrange in the real world but useful for patients to confront. Alongside in-vivo exposures, imaginal exposures may be therapeutically effective for helping patients learn to challenge and correct inflated probability and cost estimates associated with potential negative social experiences (see Beidel et al., 2014).

All three conditions were associated with similar rates of homework completion and high ratings of adherence and alliance; however, credibility scores were more moderate. Given that treatment credibility is related to engagement with CBT (e.g., Devilly & Borkovec, 2000; Söchting, Tsai, & Ogrodniczuk, 2016), future work could examine factors that influence participants' perceptions of credibility in relation to brief imagery-based interventions such as IR and IE. It may be challenging for some patients to engage deeply with these brief interventions as they are required to confront their painful memories in rapid fashion at the outset of treatment without much opportunity to acclimate more gradually to the treatment model as in traditional CBT protocols that often span 12 sessions or more.

Finally, future studies of rescripting should examine the relationship between changes in memory processes and changes in symptoms of social anxiety. Given the narrow scope and brevity of the interventions examined in the current study, we hesitate to conceptualize them as being fundamentally similar to comprehensive treatment protocols that employ a variety of procedures targeting hypothesized mechanisms over multiple sessions. Future research on IR as a comprehensive treatment could examine whether and how symptom reduction may be mediated by multiple memory-based mechanisms over time, including the incorporation of more positive episodic memory details and more positive core beliefs via the reconsolidation and/or reappraisal of negative autobiographical memories (see Phelps & Hofmann, 2019).

Despite these limitations, the present study bolsters our growing understanding of evidence-based principles of learning and memory that underlie effective psychological intervention. Though this is a preliminary study that represents the first attempt to isolate the components of IR by using active control conditions and well-validated memory interviews and coding procedures, results provide novel insights about the unique effects of rescripting on memory processes and core beliefs. Findings suggest that IR may represent a useful treatment technique for patients who report socially traumatic memories as it may facilitate the incorporation of updated and more positive information into memory representations, reduce negative appraisals, and allow for changes to negative self-schema.

Acknowledgments

Funding: This work was supported by the Canadian Institutes of Health Research [grant numbers PJT-364337 to DM and MOP-49566 to MM].

We wish to thank research assistants Kerri Adams, Nick Zabara, Zoya Amir, Maggie Michealis, Prabhjot Saini, Ruofan Ma, Taylor Hudd, Kevin C. Barber, and Jessica R. Dupasquier whose hard work was integral to the completion of this study.

Declarations of conflicts of interest: none.

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Table 1. *Pre-intervention characteristics of the study sample overall and compared between conditions*

	Overall sample (n = 33)	IR (n = 11)	IE (n = 11)	SC (n = 11)	Test statistic[a]
Age in years: M (SD)	28.00 (9.53)	26.18 (5.27)	29.91 (12.16)	27.91 (10.35)	$F_{(2,30)} = 0.41$, $p = .670$
Gender (% female)	54.5	45.5	63.6	54.5	$\chi^2 = 2.75$, $p = .742$
Ethnicity[b]					$\chi^2 = 10.03$, $p = .161$
White/European	60.6	81.8	45.5	54.5	
South Asian	18.2	9.1	36.4	9.1	
Asian	15.2	0	18.2	27.3	
Southeast Asian	3.0	9.1	0	0	
Other	3.0	0	0	9.1	
Education					$\chi^2 = 6.38$, $p = .378$
Attended and/or graduated high school	9.1	9.1	9.1	9.1	
Some college/university education	39.4	45.5	36.4	36.4	
Degree from college or university	36.4	45.5	45.5	18.2	
Post-graduate degree	15.2	0	9.1	36.4	
Employment status					$\chi^2 = 8.83$, $p = .089$
Full or part-time student	48.5	36.4	63.6	45.5	
Employed full/part-time or self-employed	39.4	63.6	36.4	18.2	
Unemployed	6.1	0	0	18.2	
Temporarily unable to work	6.1	0	0	18.2	
Marital status					$\chi^2 = 2.13$, $p = 1.000$
Single	63.6	63.6	63.6	63.6	
Married/common law/engaged	33.3	36.4	27.3	36.4	
Divorced/separated	3	0	9.1	0	
Clinical characteristics					
Psychotropic medication	21.2	27.3	18.2	18.2	$\chi^2 = 0.50$, $p = 1.000$
Comorbid anxiety disorder	39.4	38.5	27.3	45.5	$\chi^2 = 1.07$, $p = .737$
Comorbid mood disorder	24.2	36.4	18.2	18.2	$\chi^2 = 1.28$, $p = .676$
Comorbid other	27.3	27.3	18.2	36.4	$\chi^2 = 0.97$, $p = .884$
Number of comorbid diagnoses: M (SD)	1 (1.12)	1.18(1.25)	.64(.92)	1.18(1.17)	$F_{(2,30)} = 0.87$, $p = .431$
Clinical Severity Rating: M(SD)	4.97(.728)	5.09(.701)	4.82(.874)	5.00(.728)	$F_{(2, 30)} = 0.39$, $p = .684$
Memory characteristics					
Negative internal details	10.39 (5.66)	12.55 (5.48)	7.91 (4.97)	10.73 (5.97)	$F_{(2, 30)} = 1.99$, $p = .154$
Positive/neutral internal details	20.03(11.72)	27.91(13.90)	18.64(8.32)	13.55(7.76)	$F_{(2,30)} = 5.43$, $p = .010$
Memory appraisals					
Negative affect	24.27(7.82)	25.27 (8.27)	21.00(7.20)	26.55 (7.53)	$F_{(2, 30)} = 1.57$, $p = .224$
Intrusiveness	3.09 (1.18)	2.64(1.03)	3.09(1.3)	3.55(1.13)	$F_{(2,30)} = 1.70$, $p = .200$
Vividness	4.30 (.77)	4.55(.52)	4.18(.87)	4.18(.87)	$F_{(2,30)} = 0.81$, $p = .455$

[a] χ^2 values represent Fisher's Exact Test; [b] Ethnic groups are based on Canadian census categories.

Table 2. *Mixed-effect model estimated means and standard errors (in parentheses), and within group effect sizes relative to Session 1 (Cohen's d [95% confidence intervals])*

	Condition	Session 1 (pre-tx)	Session 3 (post-tx)		Session 4 (post-HW)		3-month follow-up	
		M (*SE*)	*M* (*SE*)	d_{within}	*M* (*SE*)	d_{within}	*M* (*SE*)	d_{within}
Negative internal details	IR	13.53(2.53)	13.66(2.59)	-0.03[-0.9, 0.8]	13.79(2.60)	-0.05[-0.9, 0.8]	13.92(2.96)	-0.07[-0.9, 0.9]
	IE	12.90(2.91)	15.27(2.59)	-0.43[-1.3, 0.4]	17.64(2.63)	-0.86[-1.8, 0.1]	20.01(3.01)	-1.30[-2.2, -0.4]
	SC	10.28(2.91)	9.22(2.58)	0.16[-0.7, 1.0]	8.16(2.60)	0.39[-0.5, 1.2]	7.10(2.95)	0.58[-0.3, 1.5]
Positive/ neutral internal details	IR	25.94(7.0)	31.04(6.30)	-0.49[-1.4, 0.4]	36.14(6.30)	-0.98[-1.9,-0.1]	41.24(7.02)	-1.48[-2.4, -0.5]
	IE	26.56(6.48)	33.71(5.77)	-0.69[-1.5, 0.2]	40.86(5.84)	-1.38[-2.4,-0.4]	48.01(6.68)	-2.07[-3.1, -1.0]
	SC	21.94(6.81)	20.99(6.12)	0.09[-0.7, 0.9]	20.08(6.15)	0.18[-0.7, 1.0]	19.17(6.89)	0.26[-0.6, 0.6]
Negative affect	IR	22.94(1.98)	19.30(1.76)	0.47[-0.4, 1.3]	15.66(1.77)	0.95[0.1, 1.8]	12.02(2.01)	1.42[0.5, 2.4]
	IE	20.54(1.98)	18.83(1.76)	0.22[-0.6, 1.1]	17.11(1.78)	0.46[-0.4, 1.3]	15.40(2.05)	0.67[-0.2, 1.5]
	SC	26.58(1.98)	23.35(1.75)	0.42[-0.4, 1.3]	20.12(1.76)	0.84[-0.0, 1.7]	16.89(2.01)	1.26[0.3, 2.2]
Intrusiveness	IR	2.59(0.32)	2.28(0.30)	0.27[-0.6, 1.1]	1.97(.30)	0.53[-0.3, 1.4]	1.66(.32)	0.80[-0.1, 1.7]
	IE	2.93(0.32)	2.63(0.30)	0.26[-0.6, 1.1]	2.32(.30)	0.53[-0.4, 1.4]	2.02(.33)	0.79[-0.1, 1.7]
	SC	3.45(.32)	3.12(0.40)	0.29[-0.6, 1.1]	2.78(.30)	0.57[-0.3, 1.4]	2.45(.32)	0.86[-0.0, 1.8]
Vividness	IR	4.28(0.27)	3.97(0.24)	0.40[-0.5, 1.3]	3.66(.24)	0.80[-0.1, 1.7]	3.35(.28)	1.21[0.3, 2.1]
	IE	4.07(0.27)	3.95(0.24)	0.15[-0.7, 1.0]	3.84(.24)	0.30[-0.6, 1.2]	3.72(.28)	0.44[-0.4, 1.3]
	SC	3.88(0.27)	3.63(0.24)	0.33[-0.5, 1.2]	3.38(.24)	0.65[-0.2, 1.5]	3.13(.28)	0.97[0.1, 1.9]

Note. $d_{within} = (M_{pre} - M_i)/SD_{pooled\text{-}pre}$, where $SD_{pooled\text{-}pre} = \sqrt{[(SD^2_{preIR} + SD^2_{preIE} + SD^2_{preSC})/3]}$; *M*s for effect size calculations were based on mixed-effect model estimated means; *SD*s for effect size calculations were based on the observed values shown in Table 1; *d* values greater than 1.0 indicate a decrease from baseline; *d* values less than 1.0 indicate an increase from baseline. Confidence intervals are presented to one decimal point to conserve space.

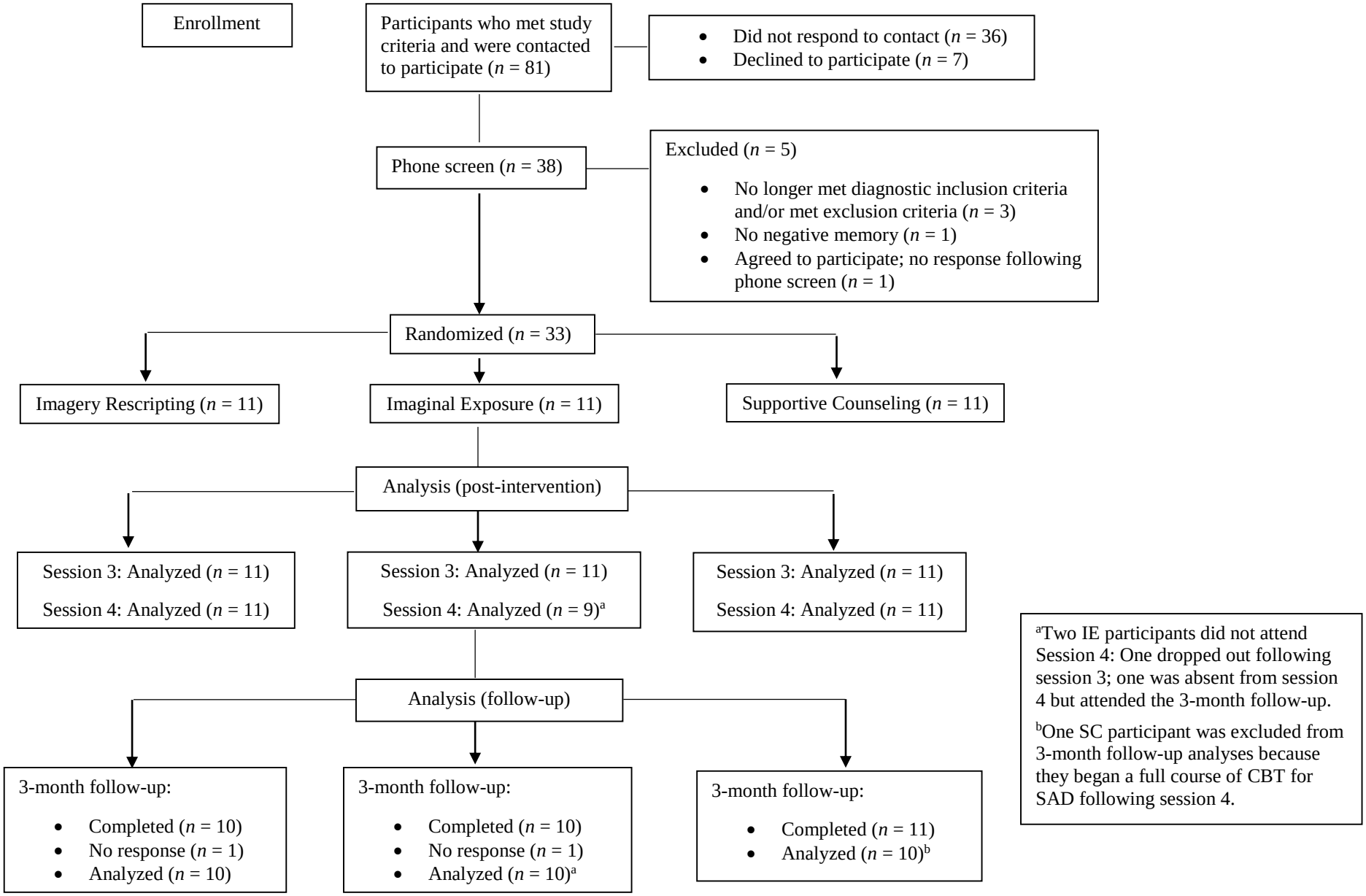

Figure 1. Flow of participants

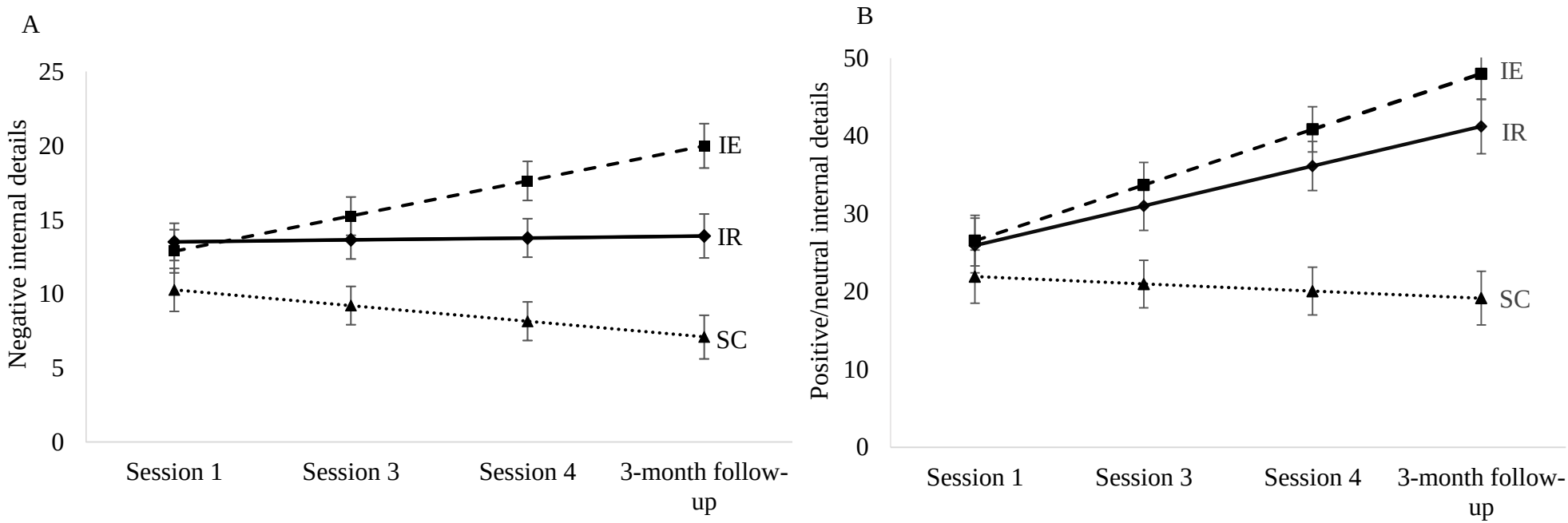

Figure 2. Intervention effects on (A) negative internal episodic details and (B) positive/neutral internal episodic details based on mixed-effect model estimated means. Note differences in slope between conditions. IE = Imaginal Exposure; IR = Imagery Rescripting; SC = Supportive Counselling; Error bars represent SE.

Supplementary Materials

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