



## Reducing depressive intrusions via a computerized cognitive bias modification of appraisals task: Developing a cognitive vaccine

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### ARTICLE INFO

#### Article history:

Received 27 August 2008

Received in revised form

9 November 2008

Accepted 14 November 2008

#### Keywords:

Depression

Intrusive memories

Cognitive bias modification

Stressful film

Imagery

Maladaptive appraisals

### ABSTRACT

A feature of depression is the distressing experience of intrusive, negative memories. The maladaptive appraisals of such intrusions have been associated with symptom persistence. This study aimed to experimentally manipulate appraisals about depressive intrusions via a novel computerized cognitive bias modification (CBM) of appraisals paradigm, and to test the impact on depressive intrusion frequency for a standardized event (a depressive film). Forty-eight participants were randomly assigned to either a session of positive or negative CBM. Participants then watched a depressing film (including scenes of bereavement and bullying) and subsequently monitored the occurrence of depressive intrusions related to the film in a diary for one week. At one-week follow-up, participants completed additional measures of intrusions – the Impact of Event Scale (IES) and an intrusion provocation task. As predicted, compared to the negative condition, participants who underwent positive CBM showed a more positive appraisal bias. Further, one week later, positive CBM participants reported fewer intrusions of the film and had lower IES scores. Our findings demonstrate that it is possible to manipulate maladaptive appraisals about depressive intrusions via a computerized CBM task. Further, this effect transfers to reducing intrusive symptomatology related to a standardized event (a depressive film) over one week, suggesting novel clinical implications.

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### Introduction

The distressing experience of negative intrusive memories is a cognitive feature of depression, and maladaptive appraisals of such memories are associated with symptom persistence. To date, research in this area to date has been correlational. In contrast, the aim of the current study was to use a computerized cognitive bias modification (CBM) of appraisals paradigm to experimentally manipulate appraisals about depressive intrusions. We tested the effects of this appraisal bias manipulation on the frequency of depressive intrusions for a standardized event (a depressing film).

Whilst intrusive negative memories do not form part of the diagnostic criteria for depression (American Psychiatric Association, 1994), or traditional formulations of cognitive therapy, growing evidence has demonstrated that these types of memories are commonly experienced by depressed patients (Birrer, Michael, & Munsch, 2007; Carlier, Voerman, & Gersons, 2000; Kuyken & Brewin, 1994). Specifically, in some samples, up to 90% of depressed patients report negative intrusive memories (Birrer et al., 2007;

Brewin, Hunter, Carroll, & Tata, 1996). Not only are such memories common across a range of psychopathologies (Holmes, Arntz, & Smucker, 2007; Holmes & Hackmann, 2004), they also appear to be as frequently experienced and to prompt the same degree of cognitive avoidance in individuals with PTSD and depression. For example, Brewin, Watson, McCarthy, Hyman, and Dayson (1998) reported that depressed cancer patients endorsed levels of intrusion and avoidance of their intrusive memories (measured by the Impact of Event Scale) that were equivalent to patients with PTSD. Birrer et al. (2007) reported that “the intrusive images were associated with as much distress in PTSD patients as in depressed patients with or without trauma” (p. 2060). They further commented that it is “surprising that intrusive images have received more attention in PTSD than in depression” (p. 2062). Patel et al. (2007) suggested that intrusive memories play a key role in maintaining depressed mood. This suggestion accords with evidence that levels of intrusion frequency and avoidance are associated with depression severity (Kuyken & Brewin, 1994) and are predictive of depression over six months (Brewin, Reynolds, & Tata, 1999).

Recent clinical studies have examined the potential benefits of targeting intrusive memories in the treatment of depression. Kandris and Moulds (2008) completed a clinical case study that suggested the utility of imaginal exposure in reducing intrusive

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memories and depression symptoms. At posttreatment and six-month follow-up, the patient no longer met diagnostic criteria for depression. Wheatley et al. (2007) conducted two case studies in which they employed imagery rescripting techniques to reduce intrusive memories in patients with depression. Their findings were promising; they reported significant reductions in depressive symptoms that were maintained at 12-month follow-up.

Negative, maladaptive appraisals of intrusive memories (e.g., *having intrusive memories means I'm crazy*) have been studied more extensively in PTSD than in depression. Cognitive models of PTSD (e.g., Ehlers & Clark, 2000) propose that when an individual assigns maladaptive appraisals to intrusive memories, the experience of these memories results in more distress, and, secondarily, prompts the use of avoidant strategies such as thought suppression. These strategies paradoxically result in the increase in the frequency of intrusions (Ehlers & Clark, 2000; Ehlers & Steil, 1995). From this perspective, maladaptive appraisals are thus a major driver in the maintenance of PTSD symptoms (Brewin & Holmes, 2003; Ehlers & Clark, 2000; Ehlers & Steil, 1995). Evidence for the role of appraisals has been provided by retrospective studies that showed significant associations between negative interpretations of intrusive memories and PTSD severity (Clohessy & Ehlers, 1999; Dunmore, Clark, & Ehlers, 1999; Steil & Ehlers, 2000), and longitudinal prospective studies in which maladaptive appraisals predicted PTSD severity over time, beyond initial symptom levels (Bryant & Guthrie, 2007; Dunmore, Clark, & Ehlers, 2001). Critical support for the importance of maladaptive appraisals was provided by Bryant and Guthrie's (2007) prospective study of trainee firefighters. They demonstrated that maladaptive appraisals [specifically the self-subscale of the Posttraumatic Cognitions Inventory (Foa, Ehlers, Clark, Tolin, & Orsillo, 1999)] endorsed prior to trauma exposure (i.e., fire fighting) predicted PTSD severity at a four-year follow-up.

Negative appraisals of intrusive memories have been studied more recently in the context of depression. Maladaptive appraisals (e.g., *having this memory means that I am weak*) have been proposed to maintain intrusive memories, and in turn, depressive symptoms (Starr & Moulds, 2006; Williams & Moulds, 2008). Starr and Moulds (2006) and subsequently Williams and Moulds (2008) showed that maladaptive appraisals of intrusions were associated with levels of depressive symptoms. Further, these associations held after controlling for the severity of the memory content and intrusion frequency. The strongest predictor of depression in these studies was the negative appraisals of the intrusions. Given their proposed role in intrusion persistence (i.e. maintaining the presence of negative intrusive memories), such maladaptive appraisals present a potential target for intervention. With this in mind, the current study experimentally tested the immediate and downstream effects of manipulating maladaptive appraisals of intrusive memories.

An experimental tool with which to manipulate cognitive biases such as appraisals of intrusive memories is the CBM paradigm. CBM is a computerized technique that was developed to systematically modify biases by repeated exposure (ca. 100 examples) to stimulus examples (Mathews & Mackintosh, 2000). The paradigm has predominantly been used to experimentally modify interpretations of ambiguous situations (Holmes, Lang, & Shah, in press; Holmes, Mathews, Dalgleish, & Mackintosh, 2006; Mathews & Mackintosh, 2000; Saleminck, van den Hout, & Kindt, 2007). Recently, Mackintosh, Woud, Potsma, Dalgleish, and Holmes (submitted for publication) extended the application of the CBM paradigm beyond ambiguous external information, and targeted the interpretation of internal cognitions; specifically, appraisals of intrusive trauma memories in a non-clinical sample. The negative training incorporated maladaptive appraisals associated with PTSD (Foa et al., 1999). The positive training condition consisted of the opposite, adaptive counterpart to each of the negative items. The impact of

the CBM was tested on a standardized analogue traumatic event known to generate intrusions – a traumatic film. Participants who completed positive CBM rated their intrusive memories of the traumatic film (over one week) as less distressing (in Experiment 1) and less frequent (in Experiment 2) than those who completed negative CBM.

For the current study, a new CBM paradigm was developed specifically to target maladaptive appraisals of intrusive memories that are associated with depression. We identified and employed the precise maladaptive appraisals endorsed by people with depressive symptoms by drawing on data from previous studies (Freeston, Ladouceur, Thibodeau, & Gagnon, 1992; Obsessive Compulsive Cognitions Working Group, 2001; Williams & Moulds, 2008). Stimuli in the negative condition utilized maladaptive appraisals such as “*Intrusive memories mean that I am coping badly*”. The positive condition utilized a corresponding opposite/adaptive version (i.e., “*Intrusive memories mean that I am coping well*”). This paradigm was tested in response to a depressive (as opposed to trauma) film that was compiled to provide an analogue of a depression-related negative event.

The aim of the current study was to test the utility of this newly developed CBM paradigm to modify depressive appraisals of intrusive memories. We predicted that: compared to the negative CBM condition, positive CBM would produce: (1) a more positive appraisal bias, as indexed by the recognition test, (2) reduced levels of intrusions of a depressing film, as indexed by three convergent measures: (i) a one-week intrusion diary, (ii) the Impact of Event Scale (IES; Horowitz, Wilner, & Alvarez, 1979), and (iii) an intrusion provocation task.

## Method

### Participants

The 40 participants comprised 19 males and 21 females, with a mean age of 27.67 years ( $SD = 9.95$ ). Participants were recruited through multiple sources: via online advertisements, posters displayed on campus, and voluntary sign-up during orientation week at two Oxford universities. For ethical reasons, the material that was used for recruitment included information that warned participants that the experiment involved viewing distressing film clips. Participants were paid a nominal amount to reimburse them for their time.

### Materials

#### Trait questionnaire measures

The trait version of the Spielberger State-Trait Anxiety Inventory (STAI-T; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to measure trait anxiety. The STAI-T consists of 20 anxiety-related items on which participants rate how they “generally feel” on a 4-point scale: *almost never*, *sometimes*, *often*, or *always*. The STAI-T is widely used and has satisfactory reliability and validity (Spielberger et al., 1983).

The tendency to use imagery in everyday life was measured using the Spontaneous Use of Imagery Scale (SUIS; Reisberg, Pearson, & Kosslyn, 2003). This questionnaire consists of 12 items, for example: “When I think about visiting a relative, I almost always have a clear mental picture of him or her”. Each item is rated on a 5-point scale, anchored with the instructions “*If a description is always completely appropriate, please write 5; if it is never appropriate, write 1; if it is appropriate about half of the time, write 3; and use the other numbers accordingly.*”

The Beck Depression Inventory-II (Beck, Steer, & Brown, 1996) was used to measure depressive symptoms. Participants respond to 21 depression-related questions with respect to how they have

been feeling during the past 2 weeks. The BDI-II possesses high internal consistency with an alpha level of 0.9 (Beck, Steer, Ball, & Ranieri, 1996). One-week test–retest reliability is also high,  $r = 0.93$  (Beck et al., 1996).

The Beck Hopelessness Scale (Beck & Steer, 1993) was used to measure degree of hopelessness about the future. Participants answered 20 true or false items such as “I look forward to the future with hope and enthusiasm.” They were instructed to give a response of “true” if the statement described their attitude in the past week.

#### State mood measure

State positive and negative affect was measured using the positive and negative affect schedule (PANAS; Watson, Clark, & Tellegen, 1988). The 41 items administered comprised the basic negative emotion scales (fear, hostility, guilt, sadness), basic positive emotion scales (joviality, self-assurance, attentiveness) and serenity subscale (included in positive score) employed by Watson and Clark (1994). These were administered with the short-term time instructions (“indicate to what extent you feel this way now/in the past few minutes”) and rated from 1 *not at all* to 5 *extremely*. This measure was administered on three occasions during the testing session.

#### CBM for appraisals materials

A script-based CBM paradigm was developed to target maladaptive appraisals of depressive intrusive memories, and was programmed using E-prime software (Versions 1.1.4.1, Pittsburgh: Psychology Software Tools Inc.). Participants responded on a standard computer keyboard. The scripts in the current study were developed based on the original paradigm devised by Mathews and Mackintosh (2000), and on the adaptations made by Mackintosh et al. (submitted for publication). They comprised 72 either positively or negatively valenced paragraphs (depending on the assigned CBM condition), in addition to 8 neutral fillers (e.g., “Intrusive memories pop into mind spontaneously”).

These CBM items were derived from a range of maladaptive cognitions from the RIQ (Clohessy & Ehlers, 1999); e.g., “Intrusive memories mean that something is wrong with me”, III (Obsessive Compulsive Cognitions Working Group, 2001); e.g., “Intrusive memories mean that I cannot cope” and the Cognitive Intrusions Questionnaire (CIQ; Freeston et al., 1992); e.g., “how much do you disapprove of having this thought or image enter your mind”. Data taken from Freeston et al. (1992), Obsessive Compulsive Cognitions Working Group (2001) and Williams and Moulds (2008) was used to calculate the correlations between dysphoria (i.e., BDI-II) and the individual items on the abovementioned measures. The appraisal items that were most strongly correlated with dysphoria were selected for inclusion in the CBM. These items were then modified to suit the CBM paradigm scripts.

In the CBM task, descriptions remained ambiguous until the final few words, which were presented as to be completed word fragments that resolved the valence/ambiguity of the paragraph. Word fragments were created such that only one solution could fit and complete the sentence. An example of an item adapted from the RIQ is as follows: “having an intrusive memory means something is wrong with me” was changed to “having an intrusive memory means *nothing* is wrong with me” for the positive CBM condition, and remained “having an intrusive memory means *something* is wrong with me” for the negative CBM condition.

Participants were instructed that they would “read a series of statements which relate to thoughts and feelings that people might have if they have had intrusive memories.” Whilst reading these statements, they were asked to imagine themselves in the situation. Statement always appeared on the screen in two parts. The first half appeared on the screen for 2 s, followed by presentation of the remainder of the statement (in the form of a word fragment).

Participants were asked to press the advance key when they knew what the first missing letter was and to type it in. The correct word then appeared on the screen.

To ensure that participants understood the meaning of the sentences, following randomly selected statements, participants were required to answer a comprehension question indicating ‘yes’ or ‘no’ as a response. For example, the CBM script item above was followed by the question “Do you believe intrusive memories mean something is wrong with you?” The questions were worded such that 50% of the time “yes” was the correct answer. The program then indicated whether participants were right or wrong by displaying “correct response” and “incorrect response”, respectively.

#### Recognition test (test of induced bias)

To determine whether the interpretation bias induction was effective, a recognition test similar to that used by Mackintosh et al. (submitted for publication) was developed. This test involved two phases. In the first phase (encoding), participants were presented with 10 ambiguous descriptions and asked to imagine themselves as vividly as they could in each. They then rated how vivid their image was on a 5-point scale from 1 (*not at all vivid*) to 5 (*extremely vivid*). The descriptions were developed using similar items of the RIQ, CIQ and III as those used in the CBM scripts. Each description began with a title; e.g., “Responding to intrusive memories”. After participants had considered the title, the description was shown (e.g., “After having spontaneous memories I try to get myself to react in a certain way that I feel is appropriate.”).

After imagining each of the 10 descriptions, participants completed the second phase of the task (recognition). New instructions explained that new descriptions would be presented along with the original titles. Participants indicated how similar or different this new description was to the original one that they read. They rated from 1 (*very different in meaning*) to 4 (*very similar in meaning*). For each of the original ambiguous descriptions, four sentences were developed, namely: a positive interpretation (positive target), negative interpretation (negative target), a positive and a negative foil. For example:

1. When I have spontaneous memories pop into my head, I always try to think about and work through them (positive target);
2. When I have spontaneous memories pop into my head, I always try to push them out of my mind (negative target);
3. When I have spontaneous memories pop into my head, I feel myself feeling more positive (positive foil);
4. When I have spontaneous memories pop into my head, I feel myself feeling more negative (negative foil).

Replicating Mackintosh et al. (submitted for publication), interpretation scores were calculated by subtracting the mean similarity rating of negative targets from the mean similarity rating of positive targets. Scores ranged from –3 to 3, where negative scores indicated a negative interpretation.

#### Depressive film

A 13 min 35 s depressing film segment that included commercial and public information films was played using Windows Media player (Version 9.00.003349, 2002) and projected onto a 1.4 m × 0.8 m screen using a data Canon projector (approximately 2 m from the participant). The segment consisted of five scenes of depressing content, namely: suicide, hopelessness, bereavement, social rejection and loss. The film included clips that showed the suicide of an old man released from prison unable to reintegrate into society, a traffic accident in which people faced the loss of a friend, the suicide of a young boy, children trying to communicate that they are being bullied, and the unexpected suicide of a woman. These clips were taken from films used in previous studies

(Schaefer, Nils, Sanchez, & Philippot, submitted for publication; Williams & Moulds, 2007).

#### Film ratings

Participants' attention to the film was measured using a visual analogue scale. Participants responded to the question "how much attention did you pay to the film being shown?" on a scale from *not at all* to *a lot*. Participants also rated how personally relevant the film clips were, and how familiar they were with them, on an 11-point scale, from 0 (*not at all relevant/familiar*) to 10 (*extremely relevant/familiar*).

#### Intrusion diary

Participants kept a daily diary over the 7 days following the film in which they recorded the occurrence of any intrusions of the film (as in Davies & Clark, 1998; Holmes, Brewin, & Hennessy, 2004). Participants recorded the content of their intrusions and the level of distress associated with them, on an 11-point scale, from 0 (*not at all distressing*) to 10 (*extremely distressing*). Participants also indicated whether their intrusion was an image, a thought or a combination of the two. Intrusive images and thoughts were distinguished for participants by the following instructions: "What goes through our minds can either take the form of words and phrases (*verbal thoughts*), or it can be like mental images. Although mental images often take the form of pictures they can actually include any of the five senses, so you can imagine sounds or smells too." Participants were given clear instructions about what was meant by unwanted intrusions (i.e., spontaneously occurring, not deliberately recalled), as well as how to complete the diary. Participants were asked to carry the diary with them to enable them to record each occurrence of an intrusion and to check at least once a day whether their diary had been completed. Participants were also instructed to make a diary entry even if they did not experience any intrusions that day. At follow-up the experimenter asked questions about the intrusions that had been reported in the diary, to ensure that they were about the film and that they occurred spontaneously.

#### Diary compliance

Compliance was measured with participants asked to; "please indicate how accurate you think the diary you completed is" from 1 (*not at all accurate*) to 10 (*extremely accurate*).

#### Impact of Event Scale (IES; Horowitz et al., 1979)

The IES is a 15-item clinical measure used to assess the subjective experience of a specific life event. It includes both an intrusion and avoidance subscale. Horowitz et al. (1979) reported satisfactory internal reliability, with alpha coefficients of 0.86 for the total score, 0.78 for the intrusion subscale and 0.82 for the avoidance subscale. For the current study, each item was adapted and anchored to the subjective experience of the film e.g., "any reminder brought back feelings about the film." This use of the IES is consistent with previous studies in which this instrument has been adapted to measure responses to stressful films (Laposa & Alden, 2006; Mackintosh et al., submitted for publication; Wessel, Overwijk, Verwoerd, & de Vrieze, 2008). Furthermore, Laposa and Alden (2006) conducted correlations between IES intrusion scores and the frequency of intrusions reported in an intrusion diary. These indices were highly correlated (i.e.,  $r = 0.69$ ), indicating that the IES is a valid measure of intrusive phenomena in response to analogue stressors.

#### Intrusion provocation task

Participants viewed 10 still pictures taken from the depressing film. The images used in this task did not include distressing content. Rather, they depicted the scenes shown prior to the most distressing parts of the film clips (i.e., the scenes known to induce

intrusions). To test the emotionality of the pictures, 10 individuals rated the valence of the images on a 9-point scale, with anchors 1 (*extremely negative*), 5 (*neutral*) and 9 (*extremely positive*). The ratings confirmed that the images selected for this task were indeed neutral, with mean ratings of 4.77 ( $SD = 0.31$ ).

Using Microsoft PowerPoint (2003), pictures were presented sequentially for 2 s at a time, with the aim of providing an analogue trigger. Participants were instructed to pay close attention to the pictures. Following viewing, participants were told to close their eyes and to try to think of anything for 2 min. Participants rested their fingers on a keyboard and recorded the occurrence of any intrusive images or thoughts by pressing different keys. Following this 2-min period, participants were asked to describe the contents of each of their intrusions in a free form question (i.e., "what were the thoughts and images you just recorded?"). In addition, participants were asked to rate the distress associated with each intrusion on an 11-point scale (where 0 = *not at all distressing* and 10 = *extremely distressing*).

#### Procedure

Participants provided informed consent to participate in the experiment and were subsequently randomly assigned to either the positive or negative CBM condition. Participants then completed the BDI-II, STAI-T, BHS, SUIIS, and PANAS. Participants were then given instructions to complete the CBM paradigm. Specifically, they were told to imagine themselves in the descriptions presented, and to perform a sentence completion task. Participants were then given instructions for the recognition test. They were told to once again imagine themselves as vividly as they could in each of the descriptions presented and rate the vividness. Participants were also informed that the second section of the task would be introduced with new instructions. Following the recognition test, participants again completed the PANAS. Participants then watched the depressing film and were re-administered the PANAS. They also completed ratings of the film. Finally, participants were given the intrusion diary along with instructions to record spontaneous intrusions of the film during the following week.

One week later, participants returned to the lab for a follow-up session. Participants completed the IES and diary compliance forms. Participants then received a diary debrief, in which they were questioned about the intrusions that they recorded, in order to verify that they were indeed spontaneous and were about the film. Participants then completed the PANAS, followed by the intrusion provocation task. The PANAS was then re-administered. Finally, participants were debriefed and thanked for their time.

## Results

### Comparison of participants in positive and negative conditions at baseline

There were no significant differences between the groups in terms of gender ( $\chi^2 [1, N = 48] = 0.33, p = .56$ ). The conditions were also comparable in terms of age, trait depression (BDI-II), trait anxiety (STAI-T), hopelessness (BHS), the tendency to use imagery (SUIIS), and state positive and negative affect (PANAS) ( $ts < 1.05, ps > .30$ ) (see Table 1).

### Film ratings and diary compliance

There was no significant difference between conditions in the attention paid to the films ( $M = 90.17, SD = 9.91$ ),  $t(46) = 0.46, p = .64$ , or diary compliance, with participants reporting high levels of accuracy ( $M = 8.42, SD = 1.07$ ),  $t(46) = 1.08, p = .29$ . There was also no significant difference between conditions in how personally

**Table 1**

Characteristics of participants at baseline per condition.

Characteristic	Positive condition (n = 24)		Negative condition (n = 24)	
	M	SD	M	SD
Age (years)	28.50	9.86	30.54	11.95
Gender (%)				
Female	54		46	
Male	46		54	
STAI trait	36.71	9.72	39.92	11.43
BDI-II	7.54	7.82	8.50	7.50
SUIS	39.21	8.34	36.71	9.33
PANAS positive	70.67	13.26	66.96	13.11
PANAS negative	29.54	10.83	28.75	8.14

Note. STAI = Spielberger State-Trait Anxiety Inventory, BDI-II = Beck Depression Inventory-II, SUIS = Spontaneous Use of Imagery Scale and PANAS = positive and negative affect schedule.

relevant the film was ( $M = 3.61$ ,  $SD = 2.74$ ),  $t(46) = 1.47$ ,  $p = .15$ , and how familiar participants were with the films ( $M = 4.20$ ,  $SD = 2.42$ ),  $t(46) = 0.33$ ,  $p = .75$ .

#### Recognition test (test of induced bias)

Participants' interpretation of novel ambiguous scripts was indexed by the recognition test. The conditions were compared using an independent samples  $t$ -test. As expected, the positive group produced more positive interpretations ( $M = 1.04$ ,  $SD = 0.76$ ) than the negative group ( $M = -0.53$ ,  $SD = 1.14$ ),  $t(46) = 5.61$ ,  $p < .001$ ,  $d = 1.62$ .

#### Effects of film on mood

A mixed model ANOVA with a between-subjects factor of condition (negative vs. positive CBM) and a within-subjects factor of time (pre- vs. post-film) with the positive subscale of the PANAS as the dependent variable yielded a main effect of time,  $F(1,46) = 10.67$ ,  $p = .002$ ,  $\eta_p^2 = 0.19$ , and no main effect of condition,  $F(1,46) = 1.93$ ,  $p = .17$ . There was no interaction between time and condition,  $F(1,46) = 1.28$ ,  $p = .26$ . Similarly, for the negative subscales, there was a main effect of time,  $F(1,46) = 5.98$ ,  $p = .02$ ,  $\eta_p^2 = 0.12$ , no main effect of condition,  $F(1,46) = 0.58$ ,  $p = .45$ , and no interaction between time and condition,  $F(1,46) = 0.30$ ,  $p = .59$ . Means are presented in Table 2.

#### Intrusion diary

Participants reported a range of both image and thought intrusions of the film in the week following CBM. Some examples of thought intrusions related to the films included: "I thought of what it could be like being in prison", "thinking abstractly about suicide", "the woman jumping from the window – why?" Some examples of

**Table 2**

Mood levels both pre- to post-film and the intrusion provocation task at one week.

Measure	Positive condition (n = 24)		Negative condition (n = 24)	
	M	SD	M	SD
PANAS positive pre-film	65.54	18.13	61.83	17.65
PANAS negative pre-film	27.25	7.47	28.42	9.14
PANAS positive post-film	60.79	15.24	52.04	18.17
PANAS negative post-film	30.67	8.24	33.79	18.06
PANAS positive pre-provocation	67.13	17.59	64.83	16.98
PANAS negative pre-provocation	28.13	7.83	28.63	10.22
PANAS positive post-provocation	62.96	17.79	56.92	15.77
PANAS negative post-provocation	27.67	9.86	29.42	9.06

Note. PANAS = positive and negative affect schedule.

image intrusions related to the films included: "I saw the old man hanging", "I saw the face of the young man who was to commit a suicide", "I saw 'I was being bullied' in my mind".

Overall, the mean total number of intrusions reported in 1 week was 4.42 ( $SD = 3.49$ ; range = 0–16). As predicted, an independent samples  $t$ -test showed that participants in the negative condition reported significantly more intrusions ( $M = 5.75$ ,  $SD = 4.19$ ) compared to the positive condition ( $M = 3.08$ ,  $SD = 1.91$ ),  $t(46) = 2.83$ ,  $p = .008$ ,  $d = 0.82$  (see Fig. 1). This result was carried by the significant difference in the number of thought intrusions ( $M = 0.42$ ,  $SD = 0.58$  for the positive condition,  $M = 2.54$ ,  $SD = 3.37$  for negative condition),  $t(46) = 3.04$ ,  $p = .006$ ,  $d = 0.88$ . By comparison, there was no difference between conditions in the number of image intrusions ( $M = 1.75$ ,  $SD = 1.33$ ),  $t(46) = 0.87$ ,  $p = .39$ .

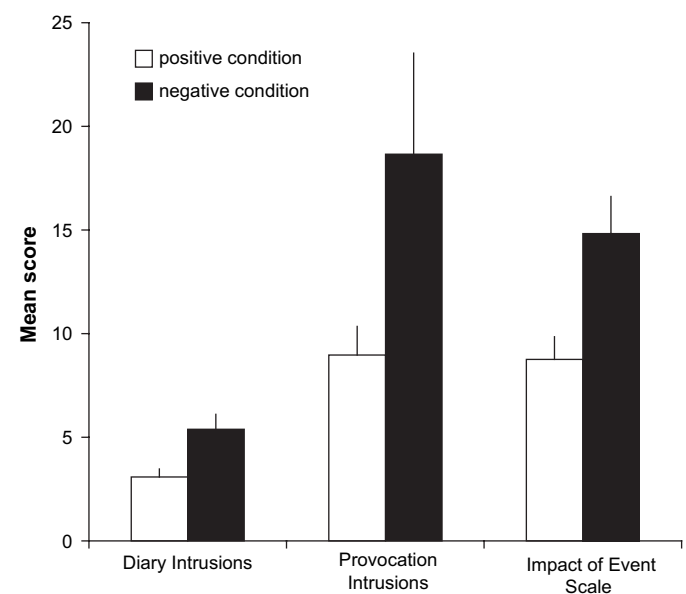
Distress ratings of intrusions were analysed for only the 43 participants who reported intrusions. Independent samples  $t$ -tests revealed no differences between conditions in the subjective distress reported associated with intrusions ( $M = 2.25$ ,  $SD = 1.99$ ),  $t(41) = 0.91$ ,  $p = .37$ . There was also no difference between conditions for either image intrusions,  $t(36) = 0.50$ ,  $p = .62$ , or thought intrusions,  $t(21) = 0.36$ ,  $p = .72$ .

#### IES

As predicted, between-group comparisons revealed that participants in the positive condition had lower overall scores on the IES than those in the negative condition,  $t(46) = 2.90$ ,  $p = .006$ ,  $d = 0.84$  (see Fig. 1). For the avoidance subscale, participants in the positive condition ( $M = 5.38$ ,  $SD = 4.49$ ) produced significantly lower scores than those in the negative condition ( $M = 7.50$ ,  $SD = 4.91$ ),  $t(46) = 2.82$ ,  $p = .008$ ,  $d = 0.69$ . However, there were no differences on the intrusion subscale ( $M = 6.44$ ,  $SD = 4.78$ ),  $t(46) = 1.57$ ,  $p = .12$ ,  $d = 0.45$ .

#### Intrusion provocation task

There was a trend towards a greater number of intrusions following the provocation task in the negative condition than in the



**Fig. 1.** Mean frequency of spontaneous intrusions reported in the one-week diary, mean frequency of intrusions reported after the provocation task and mean overall score for the Impact of Event Scale (IES) at one week for positive ( $n = 24$ ) and negative ( $n = 24$ ) CBM conditions. Error bars show one standard error of the mean.

positive condition,  $t(46) = 1.92, p = .066, d = 0.55$  (see Fig. 1). For image intrusions, there was no difference between conditions,  $t(46) = 1.60, p = .12$ , but a trend (in the predicted direction) towards a difference between conditions for thought intrusions,  $t(46) = 1.90, p = .06, d = 0.55$ .

In line with predictions, participants who reported intrusions in the negative condition reported significantly greater distress associated with intrusions during the provocation task than those in the positive condition,  $t(41) = 2.39, p = .02, d = 0.52$ . (Note: the analysis of distress ratings was conducted only on the 47 participants who reported intrusions.) This difference was significant for both image intrusions (negative group:  $M = 2.94, SD = 2.68$  vs. positive group:  $M = 1.49, SD = 1.86$ ),  $t(36) = 2.15, p = .038, d = 0.61$ , and thought intrusions (negative group:  $M = 3.06, SD = 2.68$  vs. positive group:  $M = 1.48, SD = 1.95$ ),  $t(36) = 2.04, p = .049, d = 0.63$ .

## Discussion

The current study sought to examine whether maladaptive appraisals about intrusive memories of a negative event could be altered by computerized CBM techniques. Our novel CBM paradigm was developed to encourage changes in maladaptive responding to intrusions. Our critical results were that as predicted, compared to participants who underwent negative CBM, participants who underwent positive CBM produced: 1) a greater positive appraisal bias and 2) reduced levels of intrusions evident by convergent measures of intrusive memories – i) intrusion frequency over one week reported in the intrusion diary; ii) scores on the Impact of Event Scale one week later; iii) response to an intrusion provocation task one week later. Thus, as predicted, the computerized CBM task successfully manipulated appraisal bias, and these effects transferred downstream by reducing intrusive symptomatology related to the standardized negative event. Accordingly, this study indicates both the causal influence maladaptive appraisals play in depression, and highlights the potential to modify them. To date, the research examining intrusive memories in depression has been correlational in nature. Our study is the first to experimentally manipulate appraisals of intrusions and thus demonstrate the causal impact that such thoughts have on the development of intrusions following depression-related events.

In terms of mechanisms, there are a range of potential pathways via which targeting maladaptive appraisals may have influenced intrusion frequency. Based on cognitive models of intrusive memories (Ehlers & Clark, 2000; Ehlers & Steil, 1995), it is plausible that correcting maladaptive appraisals may have reduced the motivation to avoid (e.g., suppress) intrusions, which may in turn have reduced their occurrence and associated distress. However, the mechanisms of the observed effects cannot be determined from our design. Further research is required to confirm the candidate cognitive mechanisms by which modifying appraisals of intrusions results in decreased or increased intrusion occurrence.

The use of an analogue negative event, the depressing film, provides a **standardized** event with which to compare intrusions between participants. Emotional film clips have been widely used in laboratory studies of intrusions, and such research has provided compelling evidence in the PTSD literature (Holmes & Bourne, 2008; Holmes et al., 2004). Nonetheless, for further generalizability, it would be interesting for future studies to use the current CBM paradigm with naturally experienced intrusive autobiographical memories.

Future developments of this line of research will test the potential application of the CBM paradigm to address interpretations of intrusions in a clinical sample. It would clearly be unethical to use negative CBM in a clinical sample, as it may exacerbate cognitive biases and, potentially, depressive symptoms. Hence, the use of a non-clinical sample in the current study was necessary to

test the potential effectiveness of adapting the CBM paradigm to target negative appraisals of intrusions. However, future work could explore the effectiveness of CBM in training positive appraisals in a clinical sample. At this stage our conclusions about the potential clinical utility of the current CBM paradigm are limited to making comparisons between the positive and negative CBM conditions. Future studies that compare our conditions to a neutral or no-intervention condition would provide the critical comparison condition that is needed to elucidate whether intrusions increase following negative training, decrease following positive training, or both.

With the increasing interest in computerized techniques for depression (e.g., National Institute for Health and Clinical Excellence, 2004; Proudfoot et al., 2004), and the distress associated with negative images (Holmes, Mathews, Mackintosh, & Dalgleish, 2008), future research should further explore the clinical potential of using the computerized CBM paradigm to target intrusions of negative life events. This novel paradigm provides a theory-driven, computerized medium by which to target underlying maladaptive appraisals of intrusive negative memories in depression. In this sense it departs from other computerized cognitive behaviour therapy (CBT) packages by directly targeting the underlying biases in cognition (Holmes et al., in press), rather than adapting traditional therapist-delivered CBT. Thus, while further research is necessary, we propose that CBM holds promise for further clinical research and development as part of treatment packages for depression, as a therapy component to target and reduce the prevalence and distress associated with intrusive memories.

## Acknowledgements

Tamara Lang is supported by the University of Oxford Department of Psychiatry Bursary for Overseas Students. Michelle Moulds is supported by a Fellowship from the Australian Research Council (DP0984791). Emily Holmes is supported by a Royal Society Dorothy Hodgkin Fellowship and in part by a grant from the Economic and Social Research Council (RES-061-23-0030) and a John Fell OUP Grant (PRAC/JF).

We would like to thank Dr Bundy Mackintosh for her helpful discussion.

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