APPLIED COGNITIVE PSYCHOLOGY
Appl. Cognit. Psychol. **24**: 338–350 (2010)
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/acp.1680

Modifying Interpretation and Imagination in Clinical Depression: A Single Case Series Using Cognitive Bias Modification

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SUMMARY

The current cognitive bias modification (CBM) paradigm targets interpretation bias (CBM-I) in depression *via* promoting positive imagery. We investigated the impact of repeated sessions of this CBM-I on interpretation bias, mood and mental health in participants currently experiencing a major depressive episode. Seven participants completed daily sessions of CBM-I at home for one week in a single case series. Outcome measures were completed pre and post a one-week baseline period, and after the week of daily CBM-I. Depressive symptoms were also assessed at a 2-week follow-up. Four of seven participants demonstrated improvements in mood, bias and/or mental health after one week of CBM-I, with improvements in depressive symptoms maintained at follow-up. Discussion of the remaining three highlights difficulties involved in translating CBM-I interventions from the laboratory to the clinic. To bridge this gap, we suggest that it is critical to examine the failures as well as the successes. Copyright © 2010 John Wiley & Sons, Ltd.

Cognitive accounts of depression and anxiety disorders emphasize the importance of cognitive biases. For example, people who are depressed tend to interpret ambiguous information in a negative way—a negative interpretation bias (e.g. Rude, Wenzlaff, Gibbs, Vane, & Whitney, 2002). There has been increasing interest in the development of computerized cognitive bias modification (CBM) techniques to modify such biases (MacLeod, Koster, & Fox, 2009). This paper explores a form of CBM for interpretation bias (CBM-I) that originated in the work by Mathews and Mackintosh (2000). In such CBM-I individuals are repeatedly presented with ambiguous scenarios whose interpretation is constrained in either a positive or negative way to train the corresponding bias. The longer-term aim is to use CBM as a tool to positively modify the biases of people with emotional disorders and thus improve their mental health.

The CBM-I used by Mathews and colleagues was initially targeted at anxiety. However, over a series of studies it has been developed for depression. Holmes, Mathews, Dalgleish, & Mackintosh (2006) highlighted the importance of mental imagery, rather than verbal

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processing, in positive CBM interpretation training. While the original version of the task (Mathews & Mackintosh, 2000) used sentences presented as written scripts on a computer screen, the current paradigm used auditory presentation of scenarios, which more readily allowed imagery use (Holmes & Mathews, 2005; Holmes et al., 2006). Holmes, Coughtrey, & Connor (2008a) suggested that positive CBM-I imagery should be generated from a 'field' perspective (i.e. through one's own eyes) rather than an 'observer' perspective (seeing oneself from the outside). The task instructions have been adapted accordingly in the current study. Such enhancements are likely to hold relevance to depression, as depressed mood is associated with a deficit in generating positive imagery about the future (Holmes, Lang, Moulds, & Steele, 2008b) and a bias for observer rather than field perspective imagery (Williams & Moulds, 2007). An intervention that targets both interpretation bias and positive imagery may, therefore, be particularly beneficial (Holmes, Lang, & Deeprose, 2009b). Promoting imagery may also counter the ruminative (verbal, analytical) thinking style that characterizes depression and is implicated in poor problem-solving and low mood (Watkins & Moulds, 2005; Holmes, Lang, & Shah, 2009a). Although some CBM investigations have found promising results with depressed individuals when targeting memory biases (Raes, Williams, & Hermans, 2008; Joormann, Hertel, LeMoult, & Gotlib, 2009) or rumination (Watkins, Baeyens, & Read, 2009), the current imagery-and-interpretation focussed CBM-I paradigm has yet to be tested in this clinical population.

The current study aimed to investigate the impact of our CBM-I programme on the cognitive bias, mood and mental health of participants currently experiencing a major depressive episode. A key issue for CBM-I is that if it is to have clinical value then its effects on cognitive bias and mood must endure and generalize beyond the laboratory. However, translating a paradigm from the laboratory to the clinic inevitably poses a number of challenges. Although CBM-I has been studied predominantly in healthy volunteers, more clinically relevant populations have been targeted in recent studies. For example, Mathews, Ridgeway, Cook, and Yiend (2007) found that high trait anxious participants demonstrated a reduction in trait anxiety after completion of a CBM-I programme consisting of four sessions over a 2-week period. Beard and Amir (2008) found that high socially anxious participants showed improvements in self-report social anxiety after completing eight sessions of CBM-I over 4 weeks. Salemink, van den Hout, and Kindt (2009) used a more intensive training schedule, in which high trait anxious participants completed one training session each day for eight consecutive days. Participants receiving positive CBM-I demonstrated reduced state and trait anxiety compared to a control group. While such studies highlight the promise of CBM-I for anxiety, the clinical nature of depression means that developing CBM-I for this patient group may be particularly challenging. Lack of energy, low motivation and poor concentration are defining diagnostic characteristics of depression, and thus depressed patients may find the regular practice of a repetitive computer task difficult to maintain. Furthermore, the key requirement for our CBM-I to be effective involves generation of positive imagery, which may be challenging given the imagery deficits in depression (Holmes et al., 2008b).

In light of these clinical concerns, we aimed not only to investigate whether this CBM-I paradigm could influence the interpretive biases of depressed individuals, but also to explore the potential difficulties in developing this laboratory procedure into a clinically-viable treatment component. To adapt the CBM-I paradigm to explore its accessibility for people with depression, a single case series design was adopted (e.g. Wells & Papageorgiou, 2001). This approach allowed us to use feedback from each participant to shape the procedure in an iterative process as the case series progressed, in line with

DOI: 10.1002/acp

recommendations from the Human-Computer Interaction literature (Carroll, 1997). This means that treatment 'failures' become valuable opportunities to further our understanding and to develop the paradigm. Thus we aimed to develop the computer package from a laboratory procedure towards one suitable for eventual future clinical implementation and testing.

By definition in single case design methodology a participant's baseline phase acts as their individual control period (Barlow & Hersen, 1984), and thus a treatment control group is not included. We aimed to deliver the CBM-I at one session per day over 7 days (following Salemink et al., 2009), with the addition that the first session was guided by the experimenter. We predicted that engaging in the repeated sessions of CBM-I would result in improvements in cognitive bias, mood and mental health in participants currently experiencing a major depressive episode.

METHOD

Design

A single case series using an A-B design (Barlow & Hersen, 1984) with follow-up was used. Participants completed a baseline phase of 1 week, followed by an intervention phase of 1 week. Individual baselines acted as control periods. During the baseline phase, participants completed daily ratings of mood and cognitive bias. During the intervention phase, participants were asked to complete a session of CBM-I each day at home, as well as the daily ratings. Measures of cognitive bias, depressive symptoms and mental health were completed at the initial assessment (prior to the baseline period), at the end of the baseline phase and at the end of the intervention. Two weeks after the end of the intervention, participants completed follow-up measures of depressive symptoms.

Participants

Participants were recruited through local poster advertisements. Of 66 respondents who were sent information, 22 took part in an initial screening process, completing the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) online ($N = 20$) or by post ($N = 2$). Respondents scoring above 14 (in the minimal depression range or above) on the BDI-II ($N = 17$) were invited to attend an assessment session. Five were subsequently excluded, due to reading difficulties ($N = 1$), diagnosis of schizophrenia ($N = 1$), or inability to attend sessions due to other commitments ($N = 3$). Twelve participants attended the initial assessment session. Eight were eligible to participate, meeting *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) criteria for a current major depressive episode as assessed by structured clinical interview (SCID-I; First, Spitzer, Gibbon, & Williams, 1996). One of these eight participants did not then complete the training procedure as required and was classed as a non-complier, his data were excluded from analyses.

Participants were, therefore, two men (Participants 1 and 5) and five women (Participants 2, 3, 4, 6 and 7), with a mean age of 37.7 years ($SD = 15.20$). Participant 7 also met criteria for dysthymic disorder, but otherwise no participant met criteria for any current Axis-I diagnosis other than a major depressive episode. No participants were receiving psychological therapy or taking psychoactive medication.

DOI: 10.1002/acp

Materials

There were 448 different positive training paragraphs. Of these, 100 had been used in previous studies (Holmes et al., 2006) and were read in a female voice. Of the 348 new paragraphs, 22 were read in a female voice and the remaining 326 were read in a male voice.[1] Paragraphs lasted 10–13 second, and were digitally recorded. They were presented stereophonically *via* headphones (HD-3030 Stereo Headphones), using E-Prime software (Version 1.1.4.1, Pittsburgh; Psychology Software Tools Inc.). Participants were given the option of having the software installed on their own laptop and then deleted at the end of the study, or they were lent a laptop (Microstar FID2030 Notebook PC) with only this software installed for the duration of the study.

The structure of the paragraphs was designed so that the positive outcome only became clear towards the end of the statement. For example: 'You ask a friend to look over some work you have done. They come back with some comments, which are *all very positive*' (resolution in italics). Sixty-four different training paragraphs were presented each day, organized into eight blocks of eight paragraphs. Short self-paced breaks were allowed between the blocks, during which task instruction reminders were displayed. The order of presentation of the paragraphs was identical for all participants, and had been randomized using E-Prime. To focus participants on generating imagery (Holmes et al., 2006), after each training paragraph they rated the vividness of their imagery ('How vividly could you imagine the situation than was described?') on a 5-point scale ($1 = \textit{not at all}$ and $5 = \textit{very}$). Each session started with a neutral practice item, for which the vividness rating was not recorded.

Outcome measures

Beck Depression Inventory-II (BDI-II; Beck et al., 1996). The BDI-II is a widely used measure of depressive symptoms with robust reliability and validity (Beck et al., 1996). Scores are classified as follows: Minimal depression; 14–19: Mild depression; 20–28: Moderate depression; 29–63: Severe depression (Beck et al., 1996).

Symptom-Checklist-90-Revised (SCL–90-R; Derogatis, 1992). The SCL-90-R constitutes 90 items asking about general symptoms of mental health rated on a 5–point scale from 0 (*not at all*) to 4 (*extremely*). A 'Global Severity Index' provides a summary measure of mental health across nine symptom domains including depression and anxiety. Derogatis (1992) reports good reliability and validity.

Scrambled Sentences Test (SST; Rude et al., 2002). The SST was used as a measure of depressive interpretation bias. Participants unscrambled a list of 20 scrambled sentences (e.g. *winner born I am loser a*) under a cognitive load (remembering a 6 digit number). This measured the tendency of participants to interpret ambiguous information either positively (*I am a born winner*) or negatively (*I am a born loser*). A 'negativity' score is generated by calculating the proportion of sentences completed correctly with a negative emotional valence. Rude et al. (2002) found scores on the SST to predict depressive symptoms 4–6 weeks later.

Daily measures of mood and bias

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS consists of 10 positive and 10 negative adjectives rated on a Likert-Type scale. The

[1]The vividness ratings recorded by participants for the newly constructed scenarios ($M = 3.25$, $SD = 0.43$) were similar to those for the scenarios that had been used previously ($M = 3.19$, $SD = 0.44$, $t(446) = 1.32$, $p = .19$).

DOI: 10.1002/acp

'Day' version used in this study asks participants to indicate the extent to which they 'have felt this way *today*'.

Visual Analogue Scales-Bias (VAS-Bias). These were purpose designed to provide a quick and repeatable measure of various depressive biases often encountered in clinical work. Participants rated how much each of four statements applied to them over the past day on 10 cm visual analogue scales anchored with *not at all true* at one end and *extremely true* at the other. The four statements used were *I find it difficult to imagine anything other than negative outcomes for events*, *I expect the worst*, *When something's gone wrong I feel that it's generally my fault*, and *When I've made a mistake it makes me think about how I am generally.* Following iterative feedback, from the fourth participant onwards two scales were added, asking about spontaneous positive and negative thoughts (*Positive/Negative thoughts just seem to pop into my head*).

Procedure

At the initial assessment session written informed consent was obtained from participants, followed by administration of the SCID-I and verification of eligibility. Participants then completed the outcome measures (BDI-II, SCL-90-R, SST) and continued to the baseline phase. During baseline, participants were required to complete the PANAS and VAS-Bias at home each day for 7 days (6 days for Participant 5).

The face-to-face treatment orientation session took place at the end of the baseline phase. Participants completed the outcome measures. They were then instructed and trained in generating mental imagery, with a particular emphasis on using a field perspective and not engaging in verbal processing, before completing a first session of CBM-I with the researcher. During the intervention phase, participants were required to complete one session of CBM-I independently at home each day for one week at any time of their choice. Participant 2 did not complete the fourth session due to physical illness. Participant 3 did not complete the second and third sessions due to her computer breaking, and completed the remaining four sessions at the research centre. Participants were also required to complete the daily ratings (PANAS and VAS-bias).

The final session took place with the researcher. Participants repeated the outcome measures, and were then interviewed about their experience of completing the CBM-I. Feedback from each participant was used to refine the procedure for subsequent participants in an iterative process. The refinements made are documented in the results section. From Participant 2 onwards a 2-week follow-up was added in which participants were asked to repeat the BDI-II.

RESULTS

Participants' scores on the daily measures of mood and cognitive bias are displayed in Figure 1. Scores on the three outcome measures given at assessment, pre-and post-treatment are displayed in Figure 2. Feedback from each participant and subsequent alterations to the procedure are presented in Table 1.

In line with the single case series method (Barlow & Hersen, 1984), visual inspection of graphical plots of the repeated measurements (Figures 1 and 2) was used to assess whether the pattern of changes was consistent with the study hypothesis that engaging in repeated sessions of CBM-I would result in improvements in mood, cognitive bias and mental health

DOI: 10.1002/acp

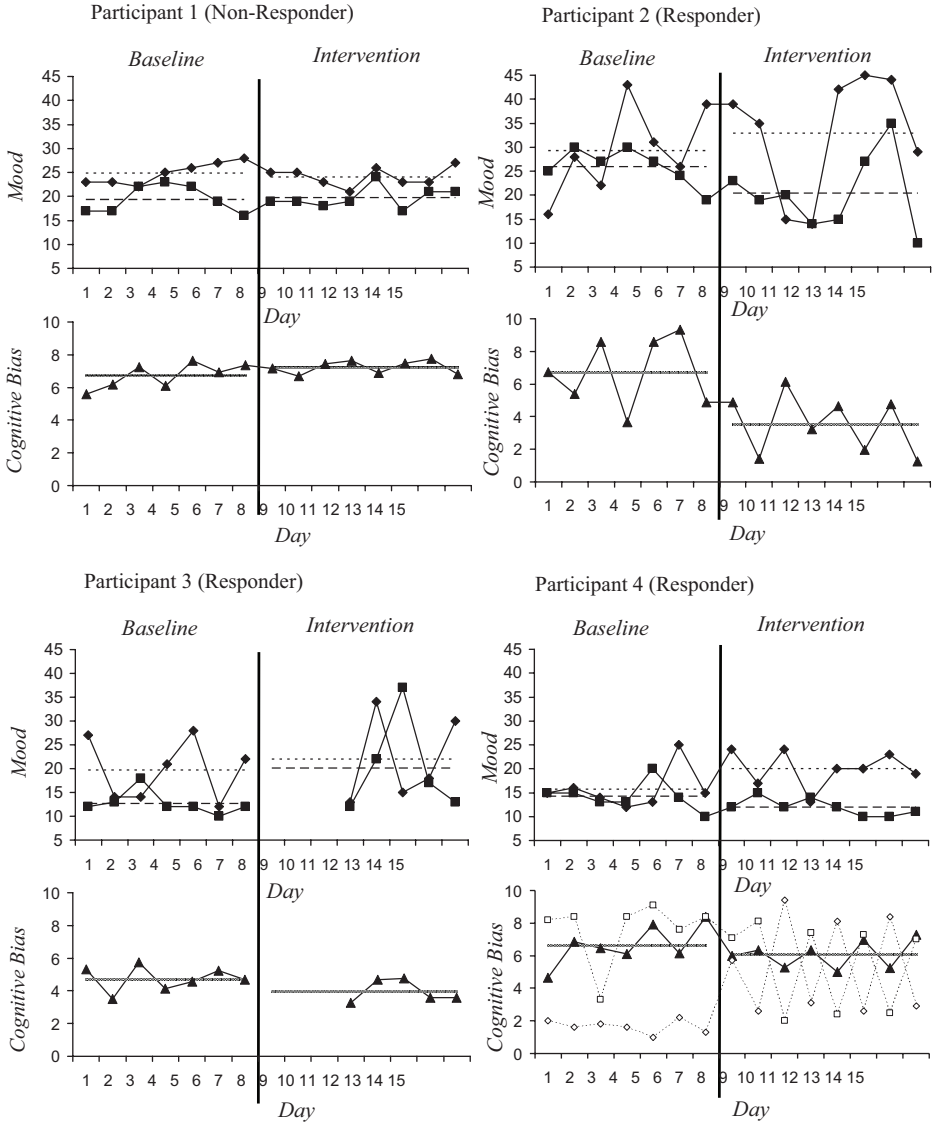

Figure 1. Scores on the daily measures of mood and bias over the baseline and intervention phases for each participant. Non-Responder/ Responder indicates whether the participant appeared to experience a positive effect from CBM-I. PANAS = Positive and Negative Affect Schedules. VAS-bias = Visual Analogue Scales-Bias. Positive/Negative automatic thoughts = response to the items Positive/Negative thoughts just seem to pop into my head

(i.e. a pattern suggesting that the crucial change occurred in the intervention phase rather than the baseline phase). We thus categorized as responders those for whom their individual pattern of change suggested an improvement following the introduction of the CBM-I task in the intervention phase, and as non-responders those for whom this was not the case.

DOI: 10.1002/acp

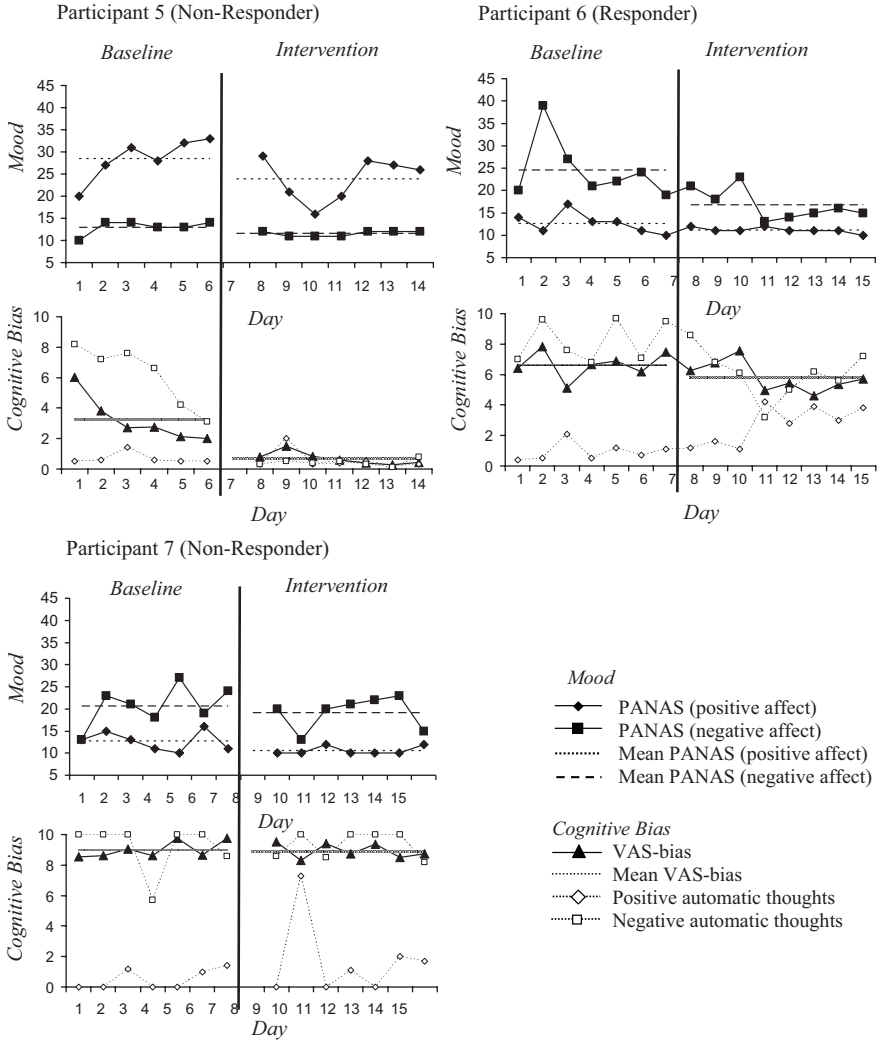

Figure 1. (Continued)

Four participants (Participants 2, 3, 4 and 6; see Figure 1, Responders) showed a pattern of changes in mood, cognitive bias or mental health consistent with the hypothesis that engaging in repeated sessions of CBM-I led to improvements. Qualitative feedback suggested a range of unexpected effects. For example, Participant 2 described experiencing auditory intrusions of the training scenarios, which she thought had a beneficial impact on her behaviour.

Three participants (Participants 1, 5 and 7; see Figure 1, Non-Responders) showed a pattern of change that did not support our hypothesis, two showing no change and one showing greater improvement over the baseline phase. Interestingly, qualitative feedback suggested that these three had experienced specific difficulties engaging with the CBM-I at home (see Table 1).

DOI: 10.1002/acp

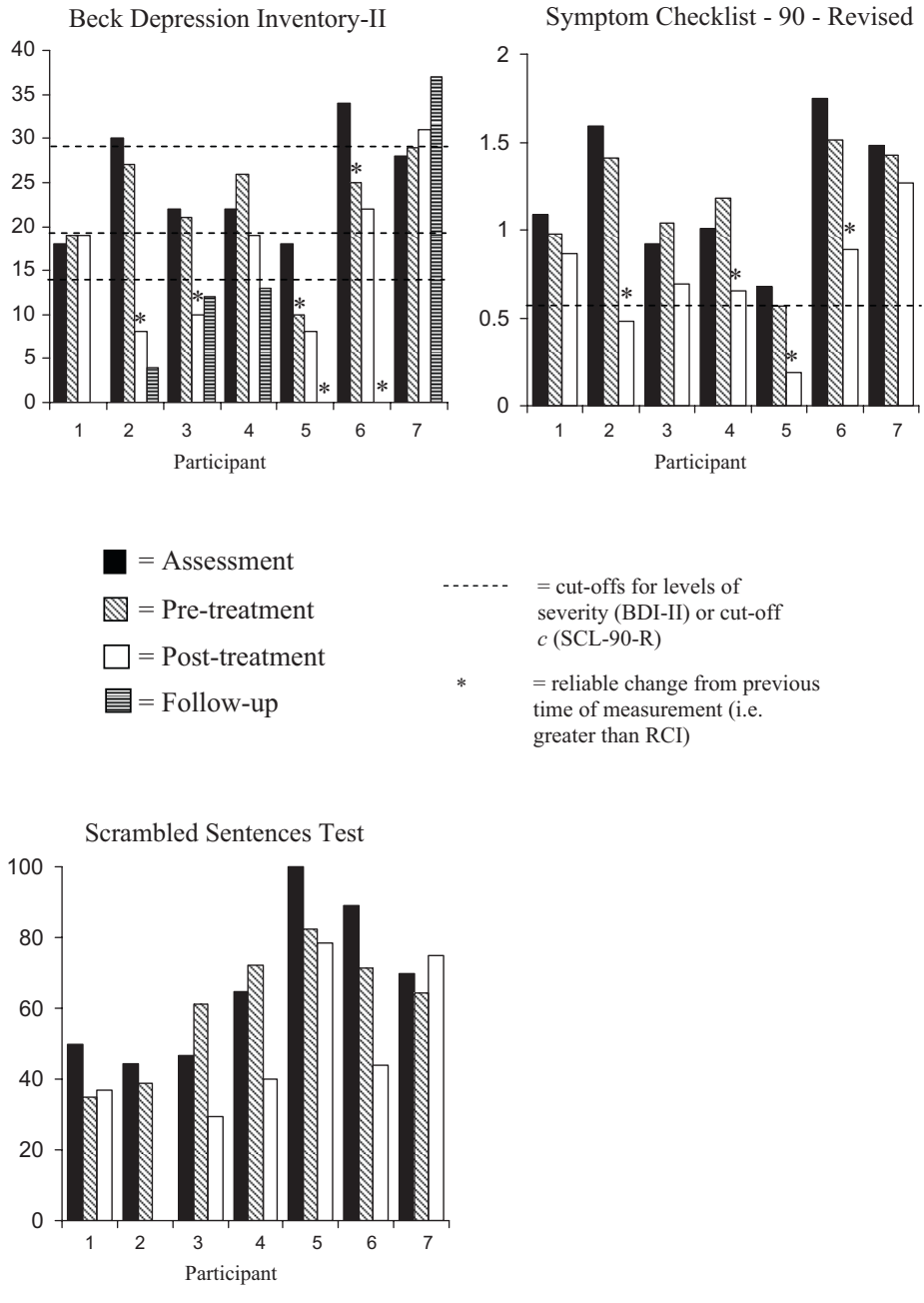

Figure 2. Scores on outcome measures at assessment, pre-treatment, post-treatment and follow-up for each participant

Clinically significant change

For the BDI-II (Beck et al., 1996), we judged change to be clinically significant if a participant moved from one category of depressive symptoms to another (e.g. moderate to mild) and if the magnitude of the change was greater than a reliable change index (RCI),

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Table 1. Qualitative feedback from participants about their experience of the CBM-I sessions

Participant	Feedback	Adjustments made
1	Had difficulty engaging with CBM-I at home—found it tedious and just tried to 'get through it' as quickly as possible (corroborated by computer records of his keystrokes/mouse clicks).	Attempted to enhance subsequent participants' motivation to engage fully with the task at home by informing them the CBM-I was like a mental 'keep fit' with possible benefits. Encouraged participants to take breaks between training blocks and not rush.
2	Realized that it was possible to imagine more positive outcomes for events. Experienced spontaneous auditory intrusions of the training scenarios in everyday life, causing her to act differently (e.g. be more sociable).	Asked subsequent participants whether they experienced auditory intrusions of scenarios and whether they had noticed changes in their actions.
3	Reported more sociable behaviour during the intervention week, and less time spent analysing interactions with people. More experience of spontaneous positive thoughts.	Added extra two questions to VAS-bias asking about experience of spontaneous positive and negative thoughts (see Method).
4	Reported more positive expectancy of day ahead during intervention phase. Less irritable and more helpful to others during intervention phase.	None
5	Spent time analysing the implications of the scenarios (verbally) and trying to work out the patterns between them. Found them too positive.	Noted difficulty engaging in CBM-I session with experimenter, so subsequent participant reporting difficulty with the first session (7) was contacted after first session of CBM-I at home to trouble-shoot difficulties, in particular emphasizing use of imagery rather than verbal processing during the intervention.
6	Experienced pleasant auditory intrusions of training scenarios. Noticed that her normal thinking patterns were very negative, and that it was possible to think differently.	None
7	Found a number of the scenarios aversive (e.g. social situations), and resented 'being told how to feel', triggering verbal processing.	

Note: CBM-I = Cognitive Bias Modification-Interpretation programme.

calculated according to the methodology described by Jacobson and Truax (1991). Jacobson and Truax used the reliability of a measure to calculate a 95% confidence level of change. For the BDI-II, an RCI of 7.16 was used, calculated from reported standardization data (Beck et al., 1996; Steer, Brown, Beck, & Sanderson, 2001). For the SCL-90-R (Derogatis, 1992), where categorizations of different levels of severity are not used, change was said to be clinically significant if it was reliable (greater than the RCI), and if the participant's score fell below the cut-off (c) below which a score resembles those found in the general population more closely than the clinical population, as proposed by Jacobson and Truax (1991). Standardized values of RCI and c were used, with RCI = 0.43 and $c = 0.57$ (Schauenburg & Strack, 1999). Of the responders, both Participants 2 and 3

DOI: 10.1002/acp

showed clinically significant change on the BDI-II over the intervention phase, while Participant 2 additionally showed clinically significant change on the SCL-90-R over the intervention phase. Participants 4 and 6 showed reliable change on the SCL-90-R over the intervention phase, while Participant 6 additionally showed clinically significant change on the BDI-II over the baseline phase.

Two of the non-responders (Participants 1 and 7) showed no reliable or clinically significant change on either of the measures, whereas the other (Participant 5) showed clinically significant change over the baseline phase on the BDI, and clinically significant change over the intervention phase on the SCL-90-R.

Statistical analyses and effect size calculations

Table 2 shows the sample means for the outcome measures at assessment, pre-treatment, post-treatment and follow-up. To test change over time, repeated-measures ANOVAs were conducted at these three time points for the whole sample ($N = 7$).

There was a significant main effect for the BDI-II, $F(2, 12) = 4.52$, $p = .03$; SCL-90-R, $F(2,12) = 13.52$, $p < .01$ and SST, $F(2, 12) = 7.02$, $p = .01$ indicating improvements in these measures over time (see Table 2). Within-subjects contrasts indicated no significant difference between assessment and pre-treatment (i.e. over baseline) for any of the measures: BDI-II; $F(1, 6) = 1.37$, $p = .29$; SCL-90-R; $F(1, 6) = 1.00$, $p = .36$; SST; $F(1, 6) = 1.41$, $p = .28$. However, the reduction from pre-treatment to post-treatment was statistically significant for the SCL-90-R, $F(1, 6) = 16.77$, $p < .01$, and at trend level in the predicted direction for the other measures: BDI-II; $F(1, 6) = 4.29$, $p = .08$; SST; $F(1, 6) = 5.40$, $p = .06$. Thus the results are suggestive of a pattern consistent with the hypothesis that for the sample as a whole, engaging in one week of repeated CBM-I improved depressive symptoms, mental health and positive cognitive bias.

Effect size calculations (partial η^2) indicated that the mean decreases over the intervention phase of 5.71 points ($SD = 7.30$, $\eta_p^2 = .42$) for the BDI-II, .44 points ($SD = 0.28$, $\eta_p^2 = .69$) for the SCL-90-R and 17.39 ($SD = 19.74$, $\eta_p^2 = .54$) for the SST all corresponded to large effect sizes ($\eta_p^2 > .138$; Clark-Carter, 1997). Over the 3 weeks from pre-treatment to follow-up, for the six participants for whom follow-up data was collected,

Table 2. Mean outcome measures scores for all participants at four time points

	Time			
Measure	Assessment	Pre-treatment	Post-treatment	Follow-up
BDI-II				
M	24.57	22.43	16.71	11.00
SD	6.19	6.48	8.56	13.94
SCL-90-R				
M	1.22	1.16	0.72	—
SD	0.39	0.33	0.34	—
SST				
M	66.39	60.76	43.40	—
SD	21.57	17.64	26.99	—

Note: BDI-II = Beck Depression Inventory—II; SCL-90-R = the Global Severity Index of the Symptom Checklist 90-Revised; SST = Scrambled Sentences Test, negativity score.

DOI: 10.1002/acp

the mean decrease of 12.00 points ($SD = 11.87$, $\eta_p^2 = .55$) on the BDI-II also corresponded to a large effect size.

DISCUSSION

The current study presents the first test of imagery-focussed CBM-I in a clinical sample of individuals currently experiencing a major depressive episode, and found evidence that repeated, self-delivered CBM-I has the potential to modify the cognitive biases and improve the mood and mental health of people suffering from depression.

The statistical or trend level significance of the mean changes found, and corresponding large effect sizes, is of interest given the small sample size. However, this analysis disguises the fact that only four of seven participants showed evidence of a positive response to the CBM-I. While this may be seen as an adequate response rate at this stage, being comparable to that for anti-depressant medication or CBT for depression (Hollon, Thase, & Markowitz, 2002), the case series design adopted allows us to use these treatment failures to further develop the paradigm and maximize its potential efficacy. It is apparent that non-responders had a qualitatively different experience of CBM-I, compared to the responders. One non-responder (Participant 1) in fact simply did not engage with the CBM-I, instead rushing through sessions. This highlighted the importance of providing participants with a rationale to engage in what could be experienced as a tedious, repetitive, task so that they were motivated to be actively engaged as required. Feedback from the other two non-responders (Participants 5 and 7) suggested that their failure to benefit was associated with a verbal processing style, consistent with ideas that verbal (rather than imagery) processing induces unfavourable comparisons with positive material (Holmes et al., 2009a). Given the overtly positive nature of the scenarios, a gradual introduction of more positive scenarios may be more appropriate (e.g. Mathews et al., 2007). Interestingly, when Participant 7 was given further coaching in mental imagery following her difficulty with the initial CBM-I session, she reported a more successful second session, associated with a reduction in negative mood and increase in spontaneous positive thoughts the following day (see Figure 1, Participant 7, day 10). However, this improvement was not sustained in the absence of further prompts. Thus it may be possible to overcome difficulties with engaging with CBM-I through additional support, but this may need to be followed up to be maintained.

Recent discussions of the possible mechanisms of action of CBM have highlighted the potential differences between engaging in a single or repeated sessions (MacLeod et al., 2009). The qualitative feedback in our study suggests that a combination of implicit and explicit processes may be involved, including increased metacognitive insight, and intrusions of training scenarios into everyday life. These intrusions appeared to be spontaneous memories formed from listening to the scenarios (*cf.* Krans, Naring, Holmes, & Becker, 2010), and were associated with positive affect. Some participants also reported that these intrusions influenced their behaviour (see Table 1). This unexpected finding would benefit from further investigation, for example by daily monitoring using a structured diary.

There are clear limitations to the conclusions that can be drawn from the current study. The small sample size limits the generalizability of the results. As we cannot be certain of the precise extent to which participants complied with the task demands while completing the CBM-I sessions at home, it may be that the effect sizes found do not reflect

DOI: 10.1002/acp

the full potential of the training schedule. The short time period of the study means that it is not clear how long the demonstrated improvements may last. The lack of a control group means that it is not possible to be certain that the effects of the CBM-I programme were not due to 'non-specific' factors such as expectancy effects or behavioural activation. As the discussion above highlights, this study suggests that the mechanisms of change in such a repeated-sessions intervention may be more complex than previously thought on the basis of single-session investigations, and thus there is a need for further research to identify the effective components. Future research would also benefit from further development of the training paragraphs to ensure their relevance to people with depression.

Despite these caveats, these initial case series findings suggest that the CBM-I paradigm merits more rigorous testing in a controlled trial. The current study represents a further step forward in bridging the world of the experimental psychology laboratory and that of the mental health clinic. Furthermore, it suggests that for some people struggling with depression, the continued development of CBM-I may indeed offer the means to generate a more positive vision of the future.

ACKNOWLEDGEMENTS

This research was supported by the Oxford Doctoral Course in Clinical Psychology research budget available to Simon E. Blackwell, and in part by a grant from the Economic and Research Council (RES-061-23-0030) awarded to Emily A. Holmes. The research was conducted for a doctoral dissertation submitted by Simon E. Blackwell in partial fulfilment of the requirements for a Doctorate in Clinical Psychology. We thank Tamara J. Lang for her help during the study and in preparing the manuscript.

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