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Developing Interpretation Bias Modification as a "Cognitive Vaccine" for Depressed Mood: Imagining Positive Events Makes You Feel Better Than Thinking About Them Verbally

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Two interpretation bias modification experiments found that mental imagery vs. verbal processing of positive material have differential emotional effects. In Experiment 1, participants were instructed to imagine positively resolved auditory descriptions or to listen to the same events while thinking about their verbal meaning. Increases in positive mood and bias were greater in the imagery than in the verbal condition, replicating E. A. Holmes, A. Mathews, T. Dalgleish, and B. Mackintosh (2006). An emotional vulnerability test showed that imagery (relative to the verbal condition) protected against a later negative mood induction. Experiment 2 created 2 new verbal conditions aimed to increase or reduce verbal comparisons. Results suggest making unfavorable comparisons with the highly positive material might be partially responsible for the inferiority of the verbal condition in Experiment 1. The findings demonstrate that imagery can play a key role in cognitive bias modification procedures and thus that task instructions are crucial. Imagining a positive event can make you feel better than thinking about the same event verbally. The authors propose that recruiting imagery will be useful in therapeutic innovations to develop a "cognitive vaccine" for depressed mood.

Keywords: mental imagery, depression, positive affect, interpretation, cognitive bias modification

Depressed and anxious people suffer from underlying biases in their style of thinking as if "filtering" information in a negative way. For example, a *negative interpretation bias* refers to the tendency to negatively interpret ambiguous stimuli (Butler & Mathews, 1983). Recent computerized cognitive bias modification (CBM) techniques that target interpretation (CBM-I) suggest possibilities for modifying such biases (Grey & Mathews, 2000; Mathews & Mackintosh, 2000; Mathews & MacLeod, 2002). CBM-I encourages individuals to repeatedly constrain potentially ambiguous interpretations in a particular direction (positive or negative) that can, over time, habitually bias the interpretation of fresh ambiguous information. CBM-I has also been shown to modify vulnerability to experiencing anxiety to a later stressor (e.g., Mackintosh, Mathews, Yiend, Ridgeway, & Cook, 2006). Using CBM-I to train negative versus benign biases allows us to examine the etiology of bias in clinical disorders (Mathews & MacLeod, 2005) and delineate influencing factors. Using CBM-I to train in a benign or positive direction offers exciting possibilities for treatment innovation. Although CBM-I methods aiming to improve clinical biases are blossoming, the optimal ingredients are yet to be identified.

Our first attempts at using "nonnegative" or benign CBM-I material failed to produce improvements in anxious mood or bias (Holmes & Mathews, 2005). Thus, Holmes, Mathews, Dalgleish, and Mackintosh (2006) developed overtly positive training material, resulting in the first successful test of positive CBM-I. This training material comprised auditory descriptions that were ambiguous initially but consistently resolved with positive outcomes. Two instruction conditions were compared. Mental imagery compared with verbal instructions had more powerful effects on (a) emotion (increases in positive affect and decreases in anxiety) and on (b) interpretation bias, even when administered after an interval to remove any difference between conditions in state mood that could otherwise be argued to drive effects. Within the imagery condition, positive affect increased over training. Unexpectedly, within the verbal condition pre- to post-, the CBM-I training phase mean positive affect scores decreased significantly, and negative bias increased. Thus, verbal instructions were not only inferior to imagery in producing positive emotion, but within this condition, mood deteriorated over training. Our objectives in the present study were to replicate this effect and to explore links to depressed bias and mood.

It could be argued that our findings in favor of imagery are at odds with other CBM-I methods showing positive effects of "verbal training." However, we believe this is not the case. The original CBM-I paradigm using verbal scripts by Mathews and Mackintosh (2000) used imagery instructions—"imagine yourself in the situation." Most subsequent studies have included imagery instructions and obtained mood effects (using auditorily presented verbal scripts: Holmes & Mathews, 2005; Holmes et al., 2006; Mackin-

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tosh et al., 2006; using visually presented verbal scripts: Mathews, Ridgeway, Cook, & Yiend, 2007; Murphy, Hirsch, Mathews, Smith, & Clark, 2007; Yiend, Mackintosh, & Mathews, 2005). It is of interest that Salemink, van den Hout and Kindt (2007) did not mention imagery in their method and found bias differences with only a marginal emotional effect.

The seminal article by Mathews and Mackintosh (2000) demonstrated that active generation of meaning was critical to producing emotional changes. Mathews and MacLeod (2002) argued that generation probably has this effect via imagery (or access to personal memories in similar form). This was confirmed by Holmes and Mathews (2005). In the only other related study we are aware of with no imagery instructions, Hirsch, Mathews, and Clark (2007) again did not find an anxiety change over training. However, training-congruent effects were obtained when participants later imagined ambiguous items and on anticipated anxiety to imagined social stress. There is rich evidence for changing semantic bias without explicit imagery instructions or mood change, as in the use of homographs in CBM-I (rather than verbal scripts). Here, spontaneous imagery during training seems implausible. For example, Wilson, MacLeod, Mathews, and Rutherford (2006) obtained effects both on bias and a challenge task (stressful films). We assume that verbal-semantic CBM-I can prime valenced semantic meanings but has little emotional impact unless imagery is also involved either during training or subsequently under circumstances when the priming influences some type of image content.

Our research has also used the CBM paradigm for a broader line of inquiry about whether mental imagery has a special relationship with emotion. Holmes et al. (2006) suggested that mental imagery can have greater effects on positive emotion than verbal processing of the same material. Why might this be the case? Clinically powerful negative mental imagery is a feature of several psychological disorders (Hackmann & Holmes, 2004), but it can also be, at least in part, positive as in substance cravings (Kavanagh, Andrade, & May, 2005) or suicidal ideation (Holmes, Crane, Fennell, & Williams, 2007). As we have argued (Holmes & Mathews, 2005), unlike verbal information, imagery has perceptual correspondence to direct sensory experience, "as if" it were really happening (Kosslyn, Ganis, & Thompson, 2001). Imagery may directly provoke emotion as a real percept might, both for positive and negative emotion. By mimicking real-life perceptions, imagery can also aid access to representations of related emotional autobiographical memories (Conway, 2001) with their accompanying emotional tone. Similar machinery is activated when imagining the future as when remembering the past (Schacter, Addis, & Buckner, 2007). Thus, as for sensory perceptual autobiographical memories, prospective imagery may also accrue emotional effects. Imagined events are more likely to be confused with reality than verbal descriptions (Hyman & Pentland, 1996). In contrast, positive verbal information may be less believable and more readily contrasted with other (disconfirmatory) information accessible in rich verbal semantic networks. This may be highly adaptive in other domains (such as debating a point of information) but proves unhelpful for being cheered by positive information.

Why might verbal processing of positive material not only be inferior to imagery but also possibly lead to paradoxical effects? In psychopathology, depression and anxiety are associated with verbal processing in the form of rumination and worry. Clinical theories across disorders converge on the idea that verbal/abstract processing may in the short term reduce negative affect, but it may also be maladaptive. The interacting cognitive subsystems theory (Teasdale & Barnard, 1993) addresses depressive rumination. The reduced concreteness theory (Stöber & Borkovec, 2002) focuses on worry, suggesting that such abstract verbal thinking is associated with reduced imagery and thus used to avoid distressing imagery. Relatedly, Hayes and Gifford (1997) suggested the cost of using verbal language to avoid negative affect can later be a paradoxical increase in negative emotion. There is evidence that inducing rumination and worry in nonclinical participants decreases positive affect (McLaughlin, Borkovec, & Sibrava, 2007).

The maladaptive subcomponent of rumination—*brooding* —is defined as a "passive comparison of one's current situation with some unachieved standard" (Treynor, Gonzalez, & Nolen-Hoeksema, 2003, p. 256). A potential account of the verbal condition findings of Holmes et al. (2006) is that participants were verbally comparing their current situation with "unachieved standards" highlighted by the overtly positive training material. Indeed, thinking about discrepancies between how one actually is (actual self) with either how one would ideally like to be (ideal self) or feel one should be (ought self) has been found to relate to depression and anxiety, respectively (Strauman & Higgins, 1987).

One can of course also make comparisons using imagery, but this may be less automatic and more effortful, requiring active switching between images (with deliberate imagery generation known to take seconds; Cocude, Charlot, & Denis, 1997), or switching between imagery and verbal modes. Furthermore, imagery can be highly absorbing; for example, flashbacks to trauma are difficult to dismiss from the mind (Brewin & Holmes, 2003). In the positive domain, individuals can indulge in positive imaginal daydreams, reveries, and fantasies (Kavanagh et al., 2005) without contradicting them until they come to an end (and then switch to comparative or verbal processing). Perhaps these absorbing and believable properties of imagery (at least in the moment) enhance the ability to benefit from even unrealistic and highly positive information.

Although our initial positive CBM-I research began in the context of anxiety, negative interpretation bias has held a central role in traditional cognitive-behavioral theories of depression (Beck, 1976). Depressed and dysphoric participants display more negative interpretation bias than controls, as indicated in numerous studies reviewed by Bisson and Sears (2007). Their study also questioned the robustness of this effect, arguing that some previous findings may be accounted for by demand. However, their review omitted two relevant studies in which methods that are less susceptible to these concerns—namely, the scrambled sentences test under a cognitive load, are used (Rude, Valdez, Odom, & Ebrahimi, 2003) and an eye blink response to ambiguous words (Lawson, MacLeod, & Hammond, 2002). Moreover, Rude et al. (2003) found bias predicted future depression. On balance, the negative interpretation bias associated with depressed mood appears to be an important therapeutic target.

Other research suggests that there may be problems related to mental imagery in depression, with high levels of negative intrusive imagery (Kuyken & Brewin, 1994), a lack of positive imagery (Williams et al., 1996), and a preponderance of verbal thought when ruminating (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002). People with depression have an overgeneral memory bias

(Williams et al., 2007), which is antithetical to generating concrete, specific mental imagery. On the basis of converging literature demonstrating negative interpretation bias and lack of positive mental imagery in depression, we predicted that our imagery-based positive CBM-I paradigm would be beneficial for alleviating depressed mood.

Experiment 1

We sought to (a) replicate the results of Holmes et al. (2006) in a larger sample and test whether positive imagery CBM-I would (b) extend to depressive bias and (c) transfer to a depression-relevant test of emotional vulnerability (negative mood induction). As our interpretation bias measure using ambiguous test descriptions (Holmes & Mathews, 2005; Holmes et al., 2006) was developed in the context of anxiety, it may not tap into a depression-relevant negative bias. Rude and colleagues (2003) found a relationship between bias on the Scrambled Sentences Test (SST; Wenzlaff, 1993) and subsequent depressive symptoms. Under cognitive load, the proportion of negative solutions on the SST predicted diagnoses of depression 18–24 months later. We therefore tested whether our overtly positive CBM-I might influence later performance on the SST.

If CBM is to be effective, then we need to demonstrate transfer of effects on later tests of emotional vulnerability. For anxiety, relevant "stressor/challenge" tests include an insoluble anagram task (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Salemink et al., 2007) and stressful film clips (Wilson et al., 2006). In the context of depressed mood, a relevant test of later emotional vulnerability is a negative mood induction.

Differential activation theory (Lau, Segal, & Williams, 2004) was developed to account for the finding that some people remain vulnerable to a reoccurrence of depressive symptoms, even when typical cognitive vulnerability markers (e.g., dysfunctional attitudes) indicate recovery. This theory asserts that it is not the "resting level" of such attitudes that is critical after recovery, but how easily these attitudes are reactivated by small changes in mood. This rationale has been extended to suicidality in depression (Williams, Barnhofer, Crane, & Beck, 2005). Because even small mood changes are thought to reactivate potentially harmful thinking styles, we argue it may be useful to develop tasks that protect against mood deterioration. We therefore tested whether our training conditions differentially affect mood following a negative mood induction.

Our key hypotheses were as follows:

> *Hypothesis 1:* We predicted that positive CBM-I would be more effective in the imagery condition compared with the verbal condition, with relatively greater reductions in anxiety, complementary increases in positive affect, and more positive interpretation bias, replicating Holmes et al. (2006). We predicted this difference would extend to the SST, a depression-relevant measure of interpretation bias.

> *Hypothesis 2:* We sought to replicate the unexpected finding from Holmes et al. (2006) of mood deterioration in the verbal condition over the training phase (specifically, increase in state anxiety, reduction in positive affect, and increased negative interpretation bias).

> *Hypothesis 3:* Conversely, within the imagery condition alone, we predicted significant improvements in mood and bias.

> *Hypothesis 4:* We predicted that compared with participants in the verbal condition, those in the imagery condition would be "protected" from mood deterioration over a later negative mood induction.

Method

Overview

Using the positive CBM-I paradigm described by Holmes et al. (2006), 100 auditory scenarios were presented. The scenarios were initially ambiguous as to their outcome then yielded consistently positive resolutions. Participants were instructed to either imagine the events or listen to them while thinking about their verbal meaning. Participants were randomized to either imagery or verbal conditions. The same training materials were used in both conditions. Mood measures (Positive and Negative Affect Schedule [PANAS]; Watson, Clark, & Tellegen, 1988; and the Spielberger State-Trait Anxiety Inventory [STAI]; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) were completed pretraining, immediately posttraining, and after a 10-min filler task. To assess interpretation bias, emotional valence ratings for ambiguous test scenarios were completed pretraining and after the filler task, and the SST was completed after the filler task. A negative mood induction was delivered, followed by a final administration of mood measures and manipulation check questions.

Participants

The 40 participants were recruited through advertisements in the local town and paid a small fee for participation; see Table 1 for characteristics.

Materials

Positive training paragraphs. One hundred descriptions used by Holmes et al. (2006) were implemented. Each one described a situation that had a positive emotional outcome. The descriptions were read aloud in the same female voice (each lasting approxi-

Table 1
Characteristics of Participants in Experiment 1

Characteristic	Imagery (n = 20) *M*	Imagery (n = 20) *SD*	Verbal (n = 20) *M*	Verbal (n = 20) *SD*
Age (years)	29.05	8.68	32.90	13.94
Gender (%)				
Women	50		60	
Men	50		40	
STAI Trait	33.65	8.54	34.80	7.92
BDI-II	4.00	3.04	4.75	3.73
SUIS	3.75	0.63	3.66	1.12

Note. STAI = State-Trait Anxiety Inventory; BDI-II = Beck Depression Inventory-II; SUIS = Spontaneous Use of Imagery Scale.

mately 10–13 s) and digitally recorded using Cool Edit 2000 software (Syntrillium Software Corporation; Phoenix, AZ). The descriptions were presented stereophonically via headphones using E-Prime software (Version 1.1.4.1; Psychology Software Tools Inc.; Pittsburgh, PA). An example is as follows: "You have started an evening class which is tough going. You are determined to succeed, and after a while, it becomes much *easier and more enjoyable*"(resolution in italics). The initial part of the scenario was designed to be ambiguous in the sense that it could also imply a negative outcome (finding class difficult). A second example was "You are starting a new job that you very much want. You think about what it will be like and feel *extremely optimistic*" (resolution in italics). The initial part of the scenario, despite being generally positive, was still intended to be somewhat ambiguous, as it could be resolved with overtly positive outcomes such as "feel pleased" or even "feel concerned." There was a 2-s gap after each description. Items were randomized throughout five training blocks, each consisting of 20 paragraphs.

Consistent with Holmes et al. (2006), in order to focus participants on their assigned task, after each training paragraph (and 2-s gap), they either rated vividness of imagery ("How vividly could you imagine the situation that was described?") or their ability to comprehend the description ("How difficult was it to understand the meaning of the description?"), depending on condition (imagery vs. verbal). Ratings were made on a 7-point scale ranging from 1 (*not at all*) to 7 (*very*). Task instruction reminders were given between blocks, with short breaks allowed between these blocks.

Filler task. During the 10-min interval after training, participants performed an unrelated filler task to eliminate mood differences between groups prior to the bias tests. A series of classical music extracts was played randomly, each lasting 40 s. Participants rated how pleasant they found each extract on a scale ranging from 1 (*extremely unpleasant*) to 9 (*extremely pleasant*).

Measures of interpretation bias. The SST (Wenzlaff, 1993) instructed participants to unscramble a list of 20 scrambled sentences in 2.5 min under a cognitive load. Participants were required to order five of the six words to create a grammatically correct sentence by placing a number from 1 to 5 over them. This constrained participants to select a positive or negative sentence. For example "good feel very bad I usually" could be unscrambled as "I usually feel very bad" (negative) or "I usually feel very good" (positive). Prior to unscrambling, a six-digit number was presented for 5 s and then hidden for 10 s. Participants were instructed to hold this number in mind during the task and then write it down. The aim of this concurrent task was to provide a cognitive load. Participants were given three benign practice sentences and instructed to complete the task as quickly as possible. After the task, 97.2% of participants reported the number accurately. The SST was included as an index of state bias following the experimental manipulation, whereas it is more typically used as a traitlike measure.

The ambiguous test descriptions comprised 10 positively resolvable paragraphs used by Holmes et al. (2006). The descriptions were ambiguous because potential emotional outcomes were implied but not explicitly described. They were presented before and after the training phase, without specific instructions as to encoding. Participants rated the emotional valence of each description using a 9-point scale ranging from 1 (*extremely unpleasant*) to 9 (*extremely pleasant*). For example, "You buy a new outfit for a party. Other people's reactions show how you *look.*"

Questionnaire measures. The two versions of the STAI (Spielberger et al., 1983) index trait and state anxiety separately. These widely used measures have satisfactory reliability and validity (Spielberger et al., 1983).

State positive affect was measured using the Positive Affect subscales of the PANAS (Watson et al., 1988). Negative affect items were excluded. These comprise 21 items—the basic positive emotion scales (Joviality, Self-Assurance, Attentiveness) as well as the Serenity subscale of Watson and Clark (1994). Items were administered with short-term time instructions that anchored responses to feelings within the past few minutes.

The tendency to use imagery in everyday life was measured using the Spontaneous Use of Imagery Scale (SUIS; Reisberg, Pearson, & Kosslyn, 2003). This 12-item questionnaire is rated on a 5-point scale ranging from 1 (*never appropriate*) to 5 (*always completely appropriate*) (e.g., "When I think about visiting a relative, I almost always have a clear mental picture of him or her".) Reisberg et al. (2003) found a positive relationship between the Vividness of Visual Imagery Questionnaire (Marks, 1973) and the SUIS, suggesting they measure a related concept.

The Beck Depression Inventory-II (BDI; Beck, Steer, & Brown, 1996) measured baseline depressive symptoms. This widely used measure of depression has robust reliability and validity (Beck et al., 1996).

Negative mood induction. Participants read negative Velten (1968) statements presented on Microsoft PowerPoint (2003) while listening through headphones to depressing music—the orchestral introduction by Prokofiev, Russia under the Mongolian Yoke by Prokofiev from the film Alexander Nevsky, played at half-speed as used in Williams et al. (2005). There were 30 statements repeated for 2.5 min rather than for 8 min to allow for a greater variation in response. Two visual analogue scales (VASs) were used (Williams et al., 2005) to measure how "sad" or "happy" participants were feeling "at this moment" by marking a 10-cm line ranging from *not at all* to *extremely*.

Manipulation check ratings. Participants made three ratings of their experience listening to the sentences during the training phase to assess (a) imagery processing—"How much did you find yourself thinking in images, i.e., in mental pictures and sensory impressions?"; (b) verbal processing—"How much did you find yourself verbally analyzing the meaning of the sentences?", and (c) concentration difficulties—"How much of the time did you find it difficult to focus on your task, i.e. your attention wandered and you found it difficult to concentrate?" Responses were rated on a 9-point scale ranging from 1 (*not at all*) to 9 (*all the time*).

Procedure

After giving their informed consent to the experiment, participants were randomly assigned to either the imagery or the verbal condition. They completed the BDI-II, SUIS, PANAS, and STAI (Time 1). They listened to the first administration of the ambiguous test descriptions, presented in random order, and rated each for emotional valence. The experimenter then read instructions for the assigned condition.

The instructions were identical to those used by Holmes et al. (2006). In the imagery condition, participants were given a brief practice task in which they were asked to imagine cutting a lemon. This task is routinely used in our studies to clarify what is meant by "using mental imagery" and create an experience of deliberate image generation. Participants were given four sample descriptions and asked to "imagine each event as happening to themselves" as the description unfolds while describing their mental image out loud, with the final example administered via computer. The experimenter explained that maintaining a focus on their images would help in answering the questions that followed.

In the verbal condition, participants completed an equivalent of the "cutting the lemon" task, with instructions to focus on the meaning of each description as they heard it. Participants were given four sample descriptions, with instructions to "concentrate on the words and meaning as the description unfolds." They were told not to imagine the situation. A final example was administered using the computer. The experimenter stated that focusing on the words and meaning of each description would help them to answer the questions that followed.

Participants were then given 100 auditory training descriptions in 5 randomized blocks of 20. For any participant, depending on their assigned condition, all descriptions were followed by a 2-s pause, after which a vividness rating (imagery condition) or comprehension rating (verbal condition) was completed. STAI and PANAS were repeated at the end of the training phase (Time 2). An interval of 10 min was given and filled by a neutral task. Mood measures were administered at the end of the interval to check mood equivalence between groups (Time 3; STAI, PANAS, and VAS). Participants then completed a second administration of the ambiguous test descriptions and the SST. The negative mood induction was then administered, followed by mood assessments using the PANAS and VAS (Time 4). Participants then completed the manipulation checks ratings. Finally, they were debriefed and thanked for their participation.

Table 2
Means and Standard Deviations for State Mood Measures, Bias Measures, and Manipulation Checks per Condition

	Imagery (n = 20)		Verbal (n = 20)	
Measure	*M*	*SD*	*M*	*SD*
Mood measures				
State STAI, Time 1	29.85	8.49	27.15	5.52
State STAI, Time 2	27.00	5.94	31.40	7.12
State STAI, Time 3	27.10	7.63	28.40	6.04
PANAS, Time 1	73.10	13.25	72.40	14.45
PANAS, Time 2	78.05	12.94	69.50	18.62
PANAS, Time 3	78.10	16.08	73.60	17.22
PANAS, Time 4	73.20	17.96	62.70	20.08
VAS sad, Time 3	5.65	8.79	2.00	2.51
VAS sad, Time 4	10.05	14.82	17.95	21.44
VAS happy, Time 3	75.20	17.61	73.85	17.03
VAS happy, Time 4	70.20	18.94	56.45	28.77
Bias measures				
Ambiguous test descriptions, Time 1	6.23	0.92	6.21	0.91
Ambiguous test descriptions, Time 3	6.50	1.17	6.23	1.02
Scrambled Sentences Test, Time 3	0.064	0.085	0.144	0.118
Manipulation checks				
Use of imagery	8.85	0.49	4.40	1.47
Use of verbal	4.20	3.14	6.20	2.63

Note. Time 1 = pretraining; Time 2 = immediately posttraining; Time 3 = after 10-min filler task posttraining; Time 4 = after mood induction; STAI = State-Trait Anxiety Inventory; PANAS = total positive affect score from the Positive and Negative Affect Schedule; VAS = Visual Analogue Scale ratings.

Results

All data was analyzed via SPSS Version 13.0.

Comparison of Participants in Imagery and Verbal Conditions

The groups were comparable in terms of gender, $\chi^2(1, N = 40) = 0.10$, $p = .75$, age; trait STAI, BDI-II, SUIS, and Time 1 state STAI, PANAS, and ambiguous test description ratings (ts < 1.2, ps > .25); see Tables 1 and 2.

Mood Change From Pretraining to Immediately Posttraining

State anxiety. We predicted that participants in the imagery condition would show greater reductions in state anxiety than those in the verbal condition. We tested this hypothesis by using a mixed model analysis of variance (ANOVA), with a grouping variable of condition (imagery vs. verbal) and the within-subjects variable of time (Time 1: pretraining vs. Time 2: posttraining). There was no main effect of time or condition (Fs < 1). However, as predicted, there was a significant interaction of time and condition, $F(1, 38) = 15.20$, $p < .001$, $\eta_p^2 = .29$. This interaction was decomposed by separate paired samples t tests of change over time within conditions. There was a significant decrease in anxiety in the imagery condition, $t(19) = 2.28$, $p = .04$, $d = 1.31$ (mean change = −2.85, SD = 5.60). There was a significant increase in anxiety after verbal training, $t(19) = 3.22$, $p = .005$, $d = 0.67$ (mean change = +4.25, SD = 5.91).

Positive affect. We tested the hypothesis that participants in the imagery condition would show greater increases in positive affect than those in the verbal condition by using a similar ANOVA to that described above. There was no main effect of time ($F < 1$) or condition, $F(1, 38) = 1.02$, $p = .32$. As predicted, there was a significant interaction of time and condition, $F(1, 38) = 10.67$, $p = .002$, $\eta_p^2 = .22$. The imagery group showed a significant increase in positive affect, $t(19) = 5.80$, $p < .001$, $d = 0.37$ (mean change = +4.95, SD = 3.82). In contrast, the decrease in positive affect (mean change = −2.90, SD = 10.05) in the verbal condition did not reach significance, $t(19) = 1.29$, $p = .21$, $d = 0.18$.

State Anxiety and Positive Affect After the Filler Task

An independent t test confirmed there were no significant differences between groups in positive affect or state anxiety (ts < 1, ps > .38) at Time 3 (see Table 2). Thus, there were no longer significant differences in mood between groups prior to administration of interpretation bias tests.

Interpretation Bias

The SST. A total negativity score was produced by calculating the number of negatively valenced sentences over the total number of sentences completed (Rude et al., 2003). Two participants in the imagery condition scored more than 3 standard deviations from the mean and were removed from the analysis (Tabachnick & Fidell, 1996). Using an independent samples *t* test, as predicted, negativity scores were greater in the verbal than in the imagery condition, $t(36) = 2.37$, $p = .02$, $d = 0.77$ (see Table 2). Additional analyses indicated that this effect was no longer significant when outliers were included ($t < 1$, $p > .33$).

Ambiguous test descriptions. We predicted that, compared with participants who were given imagery training, those given verbal training would rate scenarios more negatively after training. Using a similar ANOVA to those described above, there was no significant main effect of time or condition (Fs < 1). The interaction between time and training condition was not significant ($F < 1$).

Response to Negative Mood Induction

We predicted that compared with those in the verbal condition, participants in the imagery condition would show less deterioration in mood following the negative mood induction. We tested this hypothesis by using a mixed model ANOVA, with a grouping variable of condition (imagery vs. verbal) and the within-subjects variable of time (Time 3: premood induction vs. Time 4: postmood induction).

The PANAS. There was a main effect of time, $F(1, 38) = 42.74$, $p < .001$, $\eta_p^2 = .53$, qualified by a significant interaction of time and condition, $F(1, 38) = 6.16$, $p = .02$, $\eta_p^2 = .14$. There was no main effect of condition, $F(1, 38) = 1.84$, $p = .18$, $\eta_p^2 = .05$. We tested our directional hypothesis by comparing the reduction in PANAS scores from Time 3 to Time 4 between groups using an independent samples *t* test. There were greater reductions in the verbal group (mean change $= -10.90$, $SD = 8.33$) than in the imagery group (mean change $= -4.90$, $SD = 6.88$), $t(38) = 2.48$, $p = .02$, $d = 0.79$.

VAS sadness. There was a main effect of time, $F(1, 38) = 13.94$, $p = .001$, $\eta_p^2 = .27$, and no main effect of condition ($F < 1$). The interaction of time and condition, $F(1, 38) = 4.49$, $p = .004$, $\eta_p^2 = .11$, was significant. The increase in sadness in the verbal group (mean change $= 15.95$, $SD = 21.48$) was significantly greater than the increase in the imagery group (mean change $= 4.40$, $SD = 11.53$), $t(38) = 2.12$, $p = .04$, $d = 0.67$.

VAS Happiness. There was a main effect of time, $F(1, 38) = 16.10$, $p < .001$, $\eta_p^2 = .30$; a significant interaction of time and condition, $F(1, 38) = 4.94$, $p = .03$, $\eta_p^2 = .12$; and no main effect of condition, $F(1, 38) = 1.55$, $p = .22$, $\eta_p^2 = .04$. There were greater decreases in happiness in the verbal group (mean change $= -17.40$, $SD = 22.09$) than in the imagery group (mean change $= -5.00$, $SD = 11.63$), $t(38) = 2.22$, $p = .03$, $d = 0.70$.

The negative mood induction results may be partially accounted for by a differential emotional response to the ambiguous stimuli presented within this same interval. Thus, to check that mood change was not a result of bias change, we repeated the ANOVA for the PANAS, but with the SST score as a covariate. The interaction of time and condition remained significant, $F(1, 37) = 5.57$, $p = .02$, $\eta_p^2 = .13$, when SST was covaried. This is consistent with the suggestion that the response to the negative mood induction was not accounted for by completing the SST. A similar pattern of results was obtained for both VAS scales.

Manipulation Checks

Participants in the verbal condition reported using more verbal processing during the training phase, $t(38) = 2.19$, $p = .04$, $d = 0.69$, and those in the imagery condition reported using more imagery, $t(38) = 12.88$, $p < .001$, $d = 4.06$ (see Table 2). There was no significant difference between groups for reported difficulty concentrating on the task ($t < 1$, $p > .6$; $M = 2.83$, $SD = 2.19$).

Discussion

Experiment 1 replicated key findings from Holmes et al. (2006) of the benefits of imagery compared with verbal CBM-I, using a larger sample. Significantly for the CBM-I paradigm, we additionally demonstrated transfer to a novel test of emotional vulnerability—a depressive mood induction. Within the imagery condition alone, there were significant improvements in mood compared with baseline (positive affect and state anxiety). In contrast, positive CBM-I with verbal instructions led to not just a lack of mood improvement, but to an increase in anxiety over the training phase.

Within the verbal condition, we did not replicate a significant increase in negative interpretation bias on the ambiguous test scenarios, although cautions about the previous findings had been raised by Holmes et al. (2006). However, depressive interpretation bias (as gauged by the SST) was more positive after imagery than verbal CBM-I, with means in a similar range to those reported by Rude et al. (2003).

As predicted, relative to the verbal condition, the imagery condition was "protected" from mood deterioration on the negative mood induction. These results provide a stringent test of CBM-I on later emotional vulnerability because the conditions contrasted were all positive rather than varying in training valence, for example, benign versus negative, as in Wilson et al. (2006). The results also extend a test of emotional vulnerability to the novel domain of depressed mood. It is possible that the negative mood induction result may partially be accounted for by a differential emotional response to the ambiguous stimuli presented within this same interval (the bias tests). However, when covarying for SST, the interaction was retained. Future research in which further checks (e.g., post-SST mood ratings) are included could ensure that differential emotional reactions to the ambiguous stimuli themselves were not responsible for our results.

We sought to test other potential accounts of our results. The relative mood deterioration associated with the verbal condition may be due to differences between conditions in fatigue. However, this is unlikely to give a full account given the lack of difference in perceived concentration difficulties between conditions. Furthermore, manipulation check ratings were consistent with adherence to the appropriate condition instructions, although experimenter demand cannot be ruled out. Finally, there was no significant difference in mood between groups prior to the bias tests, which could have otherwise influenced results. The critical reasons for the inferiority of the verbal condition remain to be tested. Nevertheless, it will be clinically advantageous to develop CBM paradigms that do not lead to mood deterioration over the course of a session, as this could reduce compliance.

In conclusion, Experiment 1 provides evidence that instructions about how to focus on positive material in a CBM paradigm can significantly alter impact on mood, despite exposure to identical positive stimuli. We have replicated key results from Holmes et al. (2006) and successfully extended findings to depressive bias (SST). Crucially, differential CBM-I effects transferred to a depressive mood induction, indicating that positive training using imagery relative to verbal scripts was protective. Reading the self-relevant negative statements (e.g., “The future seems just one string of problems”) during the mood induction may be well matched to our (self-relevant) training descriptions in terms of transfer-appropriate processing (Hertel, 2002).

We propose that these early results suggest that imagery CBM-I may hold promise for development as a cognitive vaccine against later depressed mood. By *cognitive vaccine* we mean that analogous to medical vaccines, the CBM paradigm may be harnessed to boost peoples’ resistance to experiencing a later emotional challenge. Clinical translation will benefit from extension to further behavioral tasks in the laboratory and to an examination of responses to stressful real-world events. Researchers also need to refine what properties of CBM will best accrue resistance to later stress. The present data suggests that using imagery is worthy of further investigation.

Of interest, if mode of processing alone (imagery vs. verbal) rather than acquired positive bias was transferred, then we would not expect the present mood induction results. Our previous work has shown that negative imagery training (vs. verbal) can *increase* (rather than protect against) negative mood (Holmes & Mathews, 2005), suggesting that imagery effects are valence specific. This pattern of results would not appear to be accounted for by frameworks that focus only on mode of processing (e.g., abstract vs. concrete; Watkins, 2004; Watkins & Moulds, 2005). Future explanations in CBM will need to continue to examine the combination of mode of processing (e.g., imagery vs. verbal) with valence of bias (positive vs. negative).

As we have argued (Holmes & Mathews, 2005; Holmes et al., 2006), it is likely that using imagery is an active rather than incidental component of the original procedure developed by Mathews and Mackintosh (2000). That is, the original “imagine yourself in the situation” instructions were critical. An important implication for CBM is that in our paradigm, typical training effects found on measures of affect and emotional bias were not achieved in our paradigm with verbal instructions alone. This finding has potential clinical implications as it suggests that attending to positive information using a processing style engendered by our verbal processing instructions may even decrease rather than increase positive mood. This could have unfortunate ramifications for the use of verbal-only discussion of positive events in cognitive therapy.

To date, a limitation of our experiments is insufficient exploration of the nature of imagery or verbal processing. There are clearly different varieties of both imagery and verbal processing styles. We need to identify the active ingredients responsible for our findings. From a clinical perspective, it seems crucial to know how we might modify verbal instructions so that when presented with positive material, verbal processing might be less likely to worsen mood.

Experiment 2

What aspect of verbal processing caused the mood deterioration during the positive CBM-I training phase seen in Experiment 1 and Holmes et al. (2006)? Experimental debriefing indicated that verbal condition participants in Experiment 1 reported thoughts like “things never work out like this for me.” This alerted us to the possibility that participants may have unfavorably compared the outcome of the overtly positive scenarios with their own, not as (extremely) positive experiences. Although we did not expect our nonclinical sample to have chronically negative experiences, neither were they expected to have unusually positive lives. For example, consider the scenario “It’s a rainy day and you go outside with your umbrella. As the rain falls around you, you notice your step quickens and you whistle and feel surprisingly cheerful.” Comparing this outcome with what typically happens in real life, participants may dislike or only tolerate bad weather rather than enjoy it, so that the comparison would be negative.

We have seen that for clinical conditions, verbal processing can be associated with negative emotion. Clearly not all verbal processing will yield negative emotional effects. What cognitive mechanisms might account for paradoxical effects of verbally processing *positive* information? We suggest the most compelling explanation is that a process of making verbal comparisons with positive information known as “evaluation” can produce negative emotional consequences (Markman & McMullen, 2003). *Evaluation* is defined as “an evaluative mode of thinking characterized by the use of information about the standard as a reference point against which to evaluate one’s present standing” (Markman & McMullen, 2003, p. 245). Evaluative processing is predicted to produce affective contrast (i.e., if comparing with more positive information, negative affect would result, and vice versa).

Support for this comes from the social psychology literature that explains that social comparisons made between worse off (downward) and better off (upward) others often produce positive and negative emotions, respectively (Morse & Gergen, 1970). Furthermore, the counterfactual thinking literature argues that whereas downward counterfactual thinking (considering worse alternatives) improves affect, upward counterfactual thinking (considering better alternatives) worsens affect (Markman, Gavanski, Sherman, & McMullen, 1993).

These theories suggest ways in which being presented with positive material might make participants more negative (i.e., our verbal processing instructions may provoke “evaluative” comparisons). That is, participants may have been making comparisons between themselves and the overtly positive scenarios that may be causing the increase in negativity found in the verbal condition (but be less likely in imagery) of Experiment 1 and Holmes et al. (2006). To test this proposal, we created two new verbal conditions aimed to either increase or decrease the amount of comparisons being made. They were both based on the existing verbal condition instructions of Experiment 1, plus either (a) additionally instructing participants to compare each scenario with how things are for them in reality (the “verbal comparisons condition”) or (b) removing the reference to “focus on the meaning” in the instructions, as well as reducing the time available to make comparisons (the “verbal reduced-comparisons condition,” so-called to reflect the intention of the manipulation). The original imagery condition of Experiment 1 was included as a control.

In the verbal reduced-comparisons condition, we reduced the time available to make comparisons by removing the short gap after each auditory training scenario and speeding the scenarios (while preserving comprehension). The latter was motivated by Pronin and Wegner's (2006) study, in which participants read statements at either double or half normal reading speed. Increased speed was associated with greater increases in positive mood.

Our key hypotheses were as follows:

Hypothesis 1: Following positive CBM-I, the verbal comparisons condition, compared with either the imagery or the verbal reduced-comparisons condition, would produce greater increases in state anxiety (STAI) with complementary effects on the PANAS and on bias.

Hypothesis 2: Within the verbal comparisons condition alone there would be significant deterioration in mood and bias over the training phase. Within the imagery condition, mood and bias over the training phase would improve.

Method

Participants

A further 60 participants were recruited using the same procedure as before, see Table 3.

Materials

Positive training paragraphs. The same 100 descriptions were used as in Experiment 1. In the verbal reduced-comparisons condition, to reduce time available for making comparisons, the scenarios were played 20% faster, and the 2-s gap after each description was removed. The sound files were speeded using WavePad software (Version 3.05, NCH Swift Sound; Canberra, Australia). The mean duration of each letter was approximately 59 ms (previously 74 ms). In addition, the word *meaning* was eliminated from the instruction "focus on the words and meaning."

After each paragraph, participants rated either vividness of imagery (as in Experiment 1), ability to comprehend the scenario ("How difficult was it to understand the description?"), or difference from reality ("How different was this description compared to how things really are for you in reality?"). Ratings were made on 5-point scales ranging from 1 (*not at all vivid/difficult/different*) to 5 (*extremely vivid/difficult/different*).

Filler task. This was the same as Experiment 1.

Ambiguous test descriptions (interpretation bias). This was the same as Experiment 1.

Questionnaire measures. The BDI-II, SUIS, PANAS, and STAI were administered at baseline as before. Additionally, differences between groups in general tendency were tested to make comparisons using the Self-Guide Strength measure (Higgins, Shah, & Friedman, 1997). Participants listed six characteristics representing their ideal and ought self. They rated how much they would like (extent ratings) and how much they felt they actually possessed (actual ratings) these attributes. One ideal discrepancy score and one ought discrepancy score was calculated by subtracting extent ratings from actual ratings.

Manipulation check ratings. Imagery, verbal use, and concentration during training were assessed as in Experiment 1. In addition, participants were asked "How much did you find yourself comparing the scenarios with how things are for you are in reality as you were listening to the sentences?" using the same rating scale.

Procedure

The procedure was similar to Experiment 1, with the following exceptions:

1. The Self-Guide Strength measure was administered at baseline.

2. There were two verbal conditions with instructions modified from Experiment 1. Specifically, "Do your best to focus on the words and meanings while listening to the sentences and compare the information with how things really are for you in reality" (verbal comparisons condition) and "Do your best to focus on the words while listening to the sentences" (verbal reduced-comparisons condition).

Table 3
Characteristics of Participants in Experiment 2 per Condition

Characteristic	Imagery (n = 20)		Verbal reduced-comparisons (n = 20)		Verbal comparisons (n = 20)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Age (years)	24.40	7.23	25.15	8.16	25.30	7.07
Gender (%)						
Women	60		75		65	
Men	40		25		35	
STAI Trait	38.50	9.25	37.30	11.82	37.30	10.20
BDI-II	7.20	4.95	8.50	7.56	7.25	7.18
SUIS	4.00	0.61	3.73	0.87	3.98	0.76
Ideal discrepancy	4.05	1.61	4.35	2.60	4.90	2.27
Ought discrepancy	3.45	1.96	3.90	1.89	4.05	1.57

Note. STAI = State-Trait Anxiety Inventory; BDI-II = Beck Depression Inventory-II; SUIS = Spontaneous Use of Imagery Scale; the ideal and ought discrepancy ratings were taken from the Self-Guide Strength measure.

3. In the verbal reduced-comparisons condition, the auditory training stimuli were played 20% faster, and the gap after each description was removed.

4. The SST and negative mood induction were excluded as our focus in Experiment 2 was on the impact of verbal comparisons on previous training effects of mood and bias (rather than on transfer effects to depression related measures per se).

Results

Comparison of Participants in Verbal Comparisons, Verbal Reduced-Comparisons, and Imagery Conditions

There were no significant differences between conditions in gender, $\chi^2(2, N = 60) = 1.05$, $p = .59$; see Table 3. Conditions were comparable in terms of age, trait anxiety (STAI), imagery (SUIS), positive affect (PANAS), depression (BDI-II), and ambiguous test scenarios ($Fs < 1$); see Table 4. There were no differences on a measure potentially related to our experimental manipulation, the Self-Guide Strength measure ($F < 1$); see Table 3.

Mood Change From Pretraining to Immediately Posttraining

State anxiety. We predicted that participants in the verbal comparisons condition would experience greater increases in anxiety relative to either the verbal reduced-comparisons or imagery condition. Repeating the analysis of state anxiety used in Experiment 1, we found no main effects (Fs < 1). As predicted, there was a significant interaction between time and condition, $F(2, 57) = 6.31$, $p = .002$, $\eta_p^2 = .18$. Using independent samples t tests, as expected, anxiety increased significantly more in the verbal comparisons than in the verbal reduced-comparisons group (mean change = +3.8, SD = 5.85 vs. −1.55, SD = 7.49), $t(38) = 2.52$, $p = .016$, $d = 0.80$. The predicted difference between the verbal comparisons and imagery group was also significant (mean change in imagery −2.7, SD = 4.91), $t(38) = 3.81$, $p < .001$, $d = 1.20$. There was no significant difference between the imagery and verbal reduced-comparisons groups ($t < 1$, $p > .56$).

Paired samples t tests revealed, as predicted, a significant increase in anxiety over training within the verbal comparisons condition, $t(19) = 2.91$, $p = .009$, $d = 0.49$, and a significant decrease in anxiety within the imagery condition, $t(19) = 2.46$, $p = .024$, $d = 0.43$. There was no significant change in anxiety within the verbal reduced-comparisons condition, ($t < 1$, $p > .36$).

Notably, the inclusion of a Bonferroni correction (a conservative protection against an inflated alpha caused by computing three between-condition comparisons) in our analyses (.05 / 3 = .017) did not change the pattern of results.

Positive affect. We hypothesized that the verbal comparisons condition compared with both verbal reduced-comparisons and imagery conditions would produce greater decreases in positive affect. Repeating the analysis for positive affect used in Experiment 1, we found a main effect of time, $F(1, 57) = 10.24$, $p = .002$, $\eta_p^2 = .15$, with positive affect decreasing, and no main effect of condition, $F(2, 57) = 1.36$, $p = .27$. There was a significant interaction between time and condition, $F(2, 57) = 3.99$, $p = .03$, $\eta_p^2 = .12$.

There was a significant difference between the verbal comparisons and imagery groups (mean change = −7.00, SD = 8.99 vs. mean change = +0.90, SD = 10.94), $t(38) = 2.50$, $p = .017$, $d = 0.79$. Unexpectedly, there was no significant difference between the verbal reduced-comparisons (mean change = −5.60, SD = 8.18) and verbal comparisons groups ($t < 1$, $p > .6$). The difference between imagery and verbal reduced-comparisons groups was significant, $t(38) = 2.13$, $p = .04$, $d = 0.67$. Paired samples t tests showed a significant decrease in positive affect within the verbal comparisons, $t(19) = 3.48$, $p = .002$, $d = 0.53$, and verbal reduced-comparisons group, $t(19) = 3.06$, $p = .006$, $d = 0.36$. Unexpect-

Table 4
Means and Standard Deviations for State Mood Measures and Bias Measures per Condition

	Imagery (n = 20)		Verbal reduced-comparisons (n = 20)		Verbal comparisons (n = 20)	
Measure	M	SD	M	SD	M	SD
Mood measures						
State STAI, Time 1	33.95	8.11	35.60	12.16	31.40	7.06
State STAI, Time 2	31.25	8.16	34.05	9.60	35.20	8.45
State STAI, Time 3	30.95	6.72	32.40	9.77	32.50	6.76
PANAS, Time 1	69.30	16.14	65.40	15.16	71.00	12.79
PANAS, Time 2	70.20	15.18	59.80	15.64	64.00	13.54
PANAS, Time 3	67.75	15.35	59.10	15.81	66.45	15.23
Bias measures						
Ambiguous test descriptions, Time 1	6.39	0.72	6.20	0.96	6.31	0.99
Ambiguous test descriptions, Time 3	6.50	0.91	6.01	1.02	6.21	0.89
Manipulation checks						
Use of imagery	8.00	0.73	3.25	1.74	3.53	1.21
Use of verbal	2.50	1.36	7.45	1.05	7.45	1.04
Use of comparisons	4.90	2.43	3.75	2.10	8.25	0.79

Note. Time 1 = pretraining; Time 2 = immediately posttraining; Time 3 = after 10-min filler task posttraining; STAI = State-Trait Anxiety Inventory; PANAS = total positive affect score from the Positive and Negative Affect Schedule.

edly, there was no significant increase in positive affect following imagery training ($t < 1$, $p > .7$).

If we include a Bonferroni correction, it affects only the (noncritical) difference between the verbal reduced-comparisons and imagery condition ($p = .04$) rendering it nonsignificant.

State Anxiety and Positive Affect After the Filler Task

A one-way ANOVA confirmed that there were no significant differences between groups at Time 3 in either state anxiety ($F < 1$) or positive affect, $F(2, 57) = 1.82$, $p = .17$.

Ambiguous Test Descriptions

Using a mixed model ANOVA, there were no main effects (Fs < 1). The interaction between time and training condition did not reach significance, $F(2, 57) = 1.67$, $p = .20$.

Manipulation Checks

The four ratings were compared using one-way ANOVAs and decomposed with independent samples t tests. For mean scores, see Table 4. First, reported use of imagery was higher in the imagery than in both verbal conditions (ps $< .001$). There were no differences between the two verbal conditions in reported use of imagery ($t < 1$, $p > .56$). Second, both verbal conditions reported using more verbal processing than the imagery condition (ps $< .001$), with no differences between verbal groups ($t < 1$, $p > .99$). Third, reported use of verbal comparisons was higher in the verbal comparisons than in the other conditions (ps $< .001$). There were no differences for use of verbal comparisons between the other two conditions, $t(38) = 1.60$, $p = .12$.

Finally, there was no significant difference between the three conditions for difficulty concentrating on the training task ($F < 1$; $M = 6.48$, $SD = 1.84$). The pattern of results did not change when a Bonferroni correction was applied.

Discussion

In Experiment 2, we sought to examine a potential mechanism to account for the finding in the present Experiment 1 and Holmes et al. (2006) that exposure to overtly positive material in a verbal instruction condition was inferior to an imagery condition, and led to mood worsening over the training phase. We proposed one possibility was that participants were unfavorably comparing the very positive training material with their personal (not so consistently positive) experiences. Such comparisons with positive information were predicted to lead to mood deterioration (Markman & McMullen, 2003; Strauman & Higgins, 1987). We therefore created two new verbal conditions that aimed to either increase or decrease comparisons. Our critical result was that positive training in the verbal comparisons condition led to greater increases in anxiety than in both other conditions. Thus, for state anxiety, the verbal reduced-comparisons condition ameliorated the negative emotional impact relative to imagery. This supports our prediction that a feature of this new condition—comparative verbal processing—contributed, at least in part, to previous findings.

The analogous pattern of results for positive affect seem less clear, though because Watson et al. (1988) have demonstrated the independence of positive and negative affect, this may be unsurprising. Unexpectedly, the positive mood increase within the imagery condition alone did not reach significance. Apart from the changes detailed to create the two new verbal conditions, only one further modification was made to Experiment 2—a measure of self-discrepancy was added prior to the training phase. Unfortunately, it may have primed participants to make comparisons by explicitly requiring them to do so just before training began. Indeed, our manipulation check ratings showed that the mean comparison score in the imagery condition reached the midrange (see Table 4). Future research needs to test our prediction that effective imagery conditions are characterized by lower ratings of comparisons.

There was no difference between conditions in difficulty concentrating during training. Manipulation check ratings were consistent with adherence to the appropriate condition instructions, though experimenter demand cannot be ruled out. For reasons given earlier, the test of emotional vulnerability in Experiment 1 was omitted in Experiment 2, and future studies should include this. Caution should still be taken in drawing conclusions, as it is always possible some further factor incidental to our experimental manipulation could account for the pattern of results. It would be interesting to compare the verbal-reduced comparisons condition with a new imagery condition matched for speed and length. However, because deliberate imagery generation is slow, reducing time in an imagery condition may be confounded with reduced imageability during CBM-I (Cocude et al., 1997). Future research should experimentally manipulate comparisons within an imagery condition to test whether this also produces negative emotional effects. As discussed, our original imagery condition may be unlikely to provoke comparative thinking, but it could be adapted. For example, our present instructions promote the use of field perspective (first-person) imagery, but we predict that alternative instructions to use observer perspective (third-person) imagery would be more likely to facilitate comparative thinking (Kuyken & Howell, 2006) and lose positive effects.

General Discussion

Our present experiments highlight differences between imagery and verbal processing instructions for positive CBM-I. First, in Experiment 1, we replicated the relative effectiveness of our positive imagery training condition on improving mood and bias, extending this to a later test of emotional vulnerability (a depression-relevant negative mood induction). That is, with identical positive training material, inferior effects on mood and bias were obtained with our standard verbal instruction condition (Experiment 1). Over the course of the training session, mood deteriorated in the verbal condition, whereas it improved within the imagery condition (Experiment 1). The relatively negative effects of the verbal condition may be due, at least in part, to participants making unfavorable personal comparisons with the highly positive material (Experiment 2). Overall, our results underscore the need to study training instructions and information processing when developing CBM. The inferiority of certain verbal conditions may present a potential source of undesired effects when attempting positive interpretation training, and possibly for other CBM paradigms (see the introduction).

In addition to the literature previously reviewed, our present findings are in line with research in the area of depressive rumination. Drawing on Teasdale and Barnard (1993), Watkins (2004) characterized a maladaptive form of ruminative processing as "conceptual-evaluative," which involves a more analytic focus on the causes, meanings and consequences, including "thinking about the self, focusing on discrepancies between current and wanted outcomes" (p. 1039). Recent support for the distinction between brooding rumination as "maladaptive" and reflection as "adaptive" comes from Rude, Maestas, and Neff (2007), who found significantly higher positive correlations between brooding, depression, and anxiety than between reflection and these mood states. Making unfavorable comparisons with positive information, as in our experiment, may tap into one aspect of maladaptive rumination. Interestingly and conversely, in Holmes and Mathews (2005), a verbal negative CBM-I condition led to less negative affect than an imagery negative CBM-I condition, suggesting that thinking verbally helped reduce negative affect (cf. Stöber & Borkovec, 2002). In this experiment, the negative training scenarios were highly negative, in comparison to which our average participant very likely had more positive daily experiences. Therefore, downward comparisons would be expected (Markman & McMullen, 2003) with an associated more positive response to negative material.

However, rather than addressing rumination per se or responses to thinking verbally about negative information, our research agenda in the present article was to explore negative responses to *positive* material. Our results are consistent with other depression research indicating a difference in affective response to positive information. Joormann and Siemer (2004) compared dysphoric and nondysphoric participants' response with thinking about positive autobiographical memories after inducing a negative mood. Although the sadness ratings of nondysphoric participants improved, those of dysphorics did not. Feldman, Joormann, and Johnson (in press) discussed dampening responses as engaging in thoughts that would likely shorten the duration of positive affect. Self-report of dampening was associated with both rumination and depression. It is possible that making unfavorable comparisons with positive information contributes to dampening and the failure of dysphorics to benefit from positive memories.

Future research using positive material within the CBM paradigm could seek to reduce the salience of unfavorable comparisons. For example, Mathews et al. (2007) exposed participants to positive training descriptions in a graded manner. Other methods could include instructions not to compare or stimulus speeding, as attempted in our experimental manipulation. Verbal processing might be particularly conducive to engaging in comparative thinking due to rich semantic networks available in a verbal mode. Switching to use imagery may be useful in this regard. Future studies also need to fractionate the effects of making comparisons and imagery more precisely. For example, observer perspective imagery may facilitate comparisons (Kuyken & Howell, 2006) and reduced affect. We predict that field imagery will be most beneficial for positive CBM.

A limitation of the present experiments is that we only contrast imagery versus verbal conditions. There are numerous control conditions and questions yet to be explored. Future research should use a third "control" condition to acquire baseline data concerning the trajectory of mood across the session in the absence of either training manipulation. Such a condition would allow the conclusion that not only whether the original verbal and imagery conditions differed in their emotional impact but also whether they made a generally negative or a generally positive contribution. It would clearly be clinically beneficial to develop CBM-I paradigms, which are enjoyable rather than aversive to do. However, it may be a challenge to design the appropriate control condition if it is to be an alternative to imagery or verbal, because it is unclear what other mode could be instructed. If participants are asked whether they think in a way that seems like having *neither* mental images nor verbal thoughts, they only infrequently endorse this, and if they do, they find it hard to describe (Holmes, Mathews, Mackintosh, & Dalgleish, in press). Alternatively, a "no-instruction" condition could be argued to be a test of spontaneous tendency of how much participants used imagery versus verbal, which would then need to be assessed and statistically controlled for.

Future studies could also add a no-training control condition (in which the positive training contingency is not present) to determine whether, in contrast, our positive training conditions exerted any impact on emotion. An interesting possibility is that just increasing imagery in the absence of a positive training contingency may have benefits for depression (e.g., Moberly & Watkins, 2006). The autobiographical memory literature (as reviewed by Williams et al., 2007) suggests that overgenerality (i.e., reduced specificity) is associated with depression. We predict that promoting imagery is an ideal candidate for increasing specificity, and thus improving depressed mood. We also predict mood may be further improved by combining an increased specificity bias with a more positive interpretation bias. Thus, for CBM-I, a positive imagery condition should exert a stronger impact than a no-training (neutral) imagery control. Relatedly, negative imagery is more powerful than neutral imagery CBM-I (Holmes & Mathews, 2005).

There are clearly many different ways in which imagery and verbal conditions can differ. For example, imagery may encourage more self-relevant processing (Holmes et al., in press), though in the context of depressed mood, self-focus is generally considered disadvantageous (Hertel & El-Messidi, 2006). Discovering what is invited by imagery or verbal modes of processing offers researchers very interesting possibilities for future research. The field of imagery and emotion is at a young stage, and we propose that an exciting web of future research will be needed to delineate the qualities and content of different types of imagery in relation to emotion.

CBM paradigms are extremely useful in identifying active ingredients in processing difficulties underlying psychopathology (Mathews & MacLeod, 2005). Furthermore, our clinically motivated concern is to harness these paradigms to ameliorate processing difficulties for treatment. As indicated by Experiment 1, our positive imagery training condition may have benefits related to both analogues of anxiety and depression, which may be useful in reality given their high comorbidity (Moffitt et al., 2007). We need to test whether beneficial effects of imagery CBM-I extend to a clinical sample—that is, to determine whether the promise of our CBM-I paradigms as a cognitive vaccine can translate to clinical reality. A thrust of future research should be to improve the positive imagery training condition and optimize real-world delivery. We suggest that harnessing mental imagery in interpretation training and related CBM paradigms is a profitable future direction.

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