Cognitive bias modification for inferential style

Noa Avirbach, Baruch Perlman & Nilly Mor

To cite this article: Noa Avirbach, Baruch Perlman & Nilly Mor (2018): Cognitive bias modification for inferential style, Cognition and Emotion, DOI: 10.1080/02699931.2018.1476321

To link to this article: https://doi.org/10.1080/02699931.2018.1476321

Published online: 19 May 2018.
Cognitive theories of depression propose a diathesis-stress model for depression, in which a maladaptive cognitive style serves as a vulnerability factor that interacts with negative life events, to predispose people to depression (Beck, 2002). Central among these theories is the hopelessness theory. This theory asserts that people differ in their inferential style, which reflects the nature of inferences they make about the causes and consequences of negative events they experience (Abramson, Metalsky, & Alloy, 1989). People who possess a negative inferential style tend to assign global and stable attributions to negative events and to infer negative consequences and negative characteristics of the self from the occurrence of the events. Possessing a negative rather than a positive inferential style was linked to higher levels of negative emotions and to hopelessness. The hopelessness theory has received wide empirical support in longitudinal and retrospective studies, which showed that a negative inferential style is a risk factor for developing major depressive disorder (Alloy et al., 2000; Hu, Zhang, & Yang, 2015). However, there is scarce direct experimental evidence to support the causal assumptions made by the theory regarding the role of negative inferential style in depression.

The paradigm of cognitive bias modification (CBM) was developed to establish causal links between cognitive processes and mechanisms and related symptoms. In CBM, participants are encouraged to adopt a certain processing or thinking style, and the effects of this mode of thinking on emotional states are then assessed. CBM research typically targets attention, interpretation or memory, and has demonstrated that cognitive biases can be changed and are causal factors in anxiety and depression (e.g. Koster & Hoorelbeke, 2015; Mogg, Waters, & Bradley, 2017).

Although inferential style has not been targeted in CBM, one study did attempt to modify attributional style using a CBM procedure and assess the effect of this modification on inferences made for a subsequent negative event and on depressed mood (Peters, Constans, & Mathews, 2011). In that study, participants were presented with scenarios that each consisted of a sentence describing a negative or a positive event. In the positive attributional style condition, participants were led to assign an unstable attribution unrelated to negative self-worth to negative events and a self-worthy, stable attribution to positive events, whereas in the negative attributional style condition the assigned causes were reversed. Compared to participants in the positive condition,
those in the negative condition made more negative attributions about their failure on a subsequent cognitive challenge, and responded to the failure with higher levels of negative mood. However, the effect of the training on mood was not mediated by the change in participants’ attributional style. Furthermore, attributions made for performance on the cognitive challenge (pre- and post-training) were the main outcome measure, and no manipulation checks were administered to assess training success in changing cognitions. The explicit and repetitive nature of the measure used, makes it vulnerable to confounds, and limits potential conclusions concerning the causal role of attributions in mood. Possibly, the most crucial limitation of the study is that it did not target all the aspects of a negative inferential style and only focused on stability and self-worth.

Thus, the first aim of the current research was to examine the causal role of inferences while addressing these limitations. Our second aim was to explore training effects on self-esteem. The hopelessness theory (Abramson et al., 1989), proposed that when negative inferential style involves internal attributions, the hopelessness depression would be characterised by low self-esteem. We designed the study to provide a test for the proposed relationship between attributions and self-esteem.

We administered a CBM procedure designed to modify inferential style, followed by a cognitive challenge. We assessed whether changing inferential style affects the inferences participants make for failing the cognitive challenge, and whether these inferences lead to changes in hope, depressed affect and self-esteem. We made several predictions. First, compared to participants in the positive inferences condition (PIC), those in the negative inferences condition (NIC) would make more negative inferences for their failure on the cognitive challenge, and would express less hope following their failure on the task. Second, following the cognitive challenge, participants in the NIC would report lower levels of mood and self-esteem than would participants in the PIC. Third, the training would change participants’ inferences towards the cognitive challenge, and in turn, these inferences would predict mood and self-esteem following the cognitive challenge.

Method

Participants

Fifty-seven undergraduates at the Hebrew University (37 females) participated in the study in return for course credit or payment (mean age was 24.16, SD = 2.16). All participants were native Hebrew speakers. The training conditions did not differ in gender ratio ($\chi^2 (1) = .21, p = .647, \text{Cramer's V} = .06$) or in age ($t(47) = −1.20, p = .234, d = −.34$).

Materials

Training phase

The training was based on previous CBM-I procedures outlined by Mathews and Mackintosh (2000). Scenarios for the training phase consisted of 30 negative and 10 positive descriptions of common events in students’ lives. Each item included a description of inferences for the event, congruent with the participant’s experimental condition. Thus, in the NIC, the 30 negative events were given stable, global and internal causes, and promoted inferred negative consequences and negative self-worth, whereas the 10 positive events were given unstable, specific and external causes without facilitating inferred positive consequences and positive personal characteristics. The reverse was true for the PIC. Because integrating all of the inference types in each event is difficult, the various inferences were balanced across events so that each inference type was sufficiently represented. Each scenario included two fragmented words, related to the promoted inferential style, for participants to complete, and was followed by two comprehension questions. Participants received feedback (correct/incorrect) on 80% of the comprehension questions, which, in most cases, was related to the inferential style and designed to facilitate it (see Table 1).

Manipulation check

Two manipulation checks were included. In the first, six probe items (similar to the training items), depicting negative events, were included throughout the training. These items were identical across the two conditions and did not include inferences. Participants’ answers to the comprehension questions reflected their own inferences about the events.

The second manipulation check (based on Lester, Mathews, Davison, Burgess, & Yiend, 2011) assessed participants’ inferential style following the training. Twelve test items were presented in a fixed randomised order, each describing a negative event presented with an identifying title. No inferences were provided for the event, and the comprehension questions did not assess inferences. Subsequently, the title
of each item was presented, along with four continuation sentences, presented randomly one at a time. Each continuation sentence described an inferred attribution; two target sentences provided continuations that reflected either a negative or a positive inferential style, and two foil sentences that reflected positive and negative inferences that were unrelated to the event. Participants were asked to rate the degree to which each sentence provided a suitable continuation for the event on a scale ranging from 1 (not suitable) to 4 (very suitable). Internal reliability for each of the sentence types was good ($\alpha = .82-93$).

**Cognitive challenge**

The Remote Associates Test (RAT; Mednick, 1962) was used to assess training effects on cognitive and emotional reactions to a stressful event. On each trial, three words were presented on the computer screen for 30 s. Participants were given 10 s to write a fourth word that relates to each of the presented words (e.g. “white” for “rabbit, cloud, house”). To create a very difficult version of RAT, ten word-puzzles with an overall average of 20% correct answers were used. Following task completion, the participant’s score was presented on the screen along with the mean score on the regular version of the test, followed by the correct answers.

**Filler task**

Because the training itself may affect participants’ mood, we used a filler task designed to neutralise mood prior to the cognitive challenge. Participants listened to six classical music pieces (Chopin, Waltz no. 11 in G flat major; Strauss, Voices Of Spring Waltz; Mozart, Rondo alla Turca; Shostakovich, Waltz No. 2; Rossini L’Italiana in Algeri Ouverture; Vivaldi, Four Seasons) each 40 s long, and rated the pleasantness of each piece on a scale ranging from 1 (not pleasant) to 10 (very pleasant).

**Self-Report measures**

**Trait measures.** A number of trait measures were administered in order to eliminate a-priori differences between the training conditions. These measures included the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), the New Attributional Style Questionnaire (NASQ; Dykema, Bergbower, Doctora, & Peterson, 1996) and the Rosenberg Self-Esteem Scale (trait-RSES; Rosenberg, 1965). Because responses to the internality dimension of the NASQ are often inconsistent (e.g. Dykema et al., 1996), it was not assessed. Internal reliability for the measures was good ($\alpha = .93, \alpha = .82, \alpha = .82$, for the BDI, NASQ, and the trait-RSES respectively).

**State hope.** The 6-item Adult State Hope Scale (Snyder et al., 1996) was used. Items are rated on an 8-point Likert scale and assess perceived effective means to attain one’s goals (e.g. “There are lots of ways around any problem that I am facing now”) and motivation and perceived ability to achieve these goals (e.g. “At the present time, I am energetically pursuing my goals”). Internal reliability was good ($\alpha = .85-88$).

**Mood.** We used three happiness-related (happy, enthusiastic and joyful) and three sadness-related items (sad, blue and depressed). Participants indicated the degree to which each item described their feeling in the present moment using a 10 cm long visual analogue scale (VAS) ranging from 0 (not at all) to 100 (extremely). The internal reliability was high ($\alpha = .91-92$, across assessments).

**State self-esteem.** The Resultant Self-Esteem Scale (state-RSES; McFarland & Ross, 1982) consists of seven positive (e.g. “right now, I feel self-confident”) and five negative self-esteem items (e.g. “right now, I feel incompetent”). Ratings were made using the same VAS used for mood. Internal reliability was good across administrations ($\alpha = .72-.9$ for positive items and $\alpha = .88-.92$ for negative items).

**Inferences.** As in Peters et al. (2011) inferences for the failure on the cognitive challenge (the RAT) were
measured using six questions adapted from the Cognitive Style Questionnaire (Alloy et al., 2006). Participants were asked to write the main cause for their failure on the RAT and then rate the extent to which the cause is stable/unstable, global/specific and internal/external, using a 7-point Likert scale. Participants also rated the importance of the failure for them, the expected negative consequences of the failure, and the degree to which the failure implies that they were unworthy or deficient. Higher scores represent a more negative inferential style. As in Peters et al. (2011), internal reliability was moderate ($\alpha = .60$).

**Procedure**

Up to one month prior to the lab visit, participants completed the BDI-II, N-ASQ, and trait RSES online. Upon arrival at the lab, participants were randomly assigned to either the PIC or the NIC. Participants completed baseline questionnaires (mood, state self-esteem, and hope). To disguise the true nature of the state questionnaires, the items of the mood and self-esteem measures were intermixed. Participants then completed the training phase: three practice items, followed by ten training blocks, each comprised of three negative events and one positive event. The order of the blocks was randomised across participants, while the presentation of the items within each block was fixed. The probe items were randomised and presented in a fixed order after the 2nd, 4th, 6th, 8th, 9th and 10th blocks. Participants then completed the manipulation check, followed by the filler task and a second set of the questionnaires (mood and state self-esteem). Next, the cognitive challenge task (the RAT) was administered, and participants completed the questionnaire assessing their inferences for their failure on this task. A third set of questionnaires (mood, state self-esteem and hope) was then administered (see Figure 1 for a diagram of the experimental procedure).

**Results**

**Participant characteristics**

The two conditions were comparable at baseline on scores on the NASQ; BDI-II, and the RSES, as well as on scores on the state measures of hope, mood and self-esteem (see Table 2 for all trait characteristics and measures repeated over the course of the experiment).

**Comprehension scores**

As indicated by the high accuracy rates on the comprehension questions across conditions (85.65% correct responses), participants understood the inferences promoted by the two training conditions. As in Peters et al. (2011), participants in the PIC were more accurate than those in the NIC ($t(52) = -2.84, p = .006, d = .77$).

**Manipulation checks**

On the first manipulation check, we compared the percentage of answers to the probe items that reflect a negative inferential style across the two training conditions. As expected, this percentage was higher among participants in the NIC than among those in the PIC ($t(52) = 6.37, p < .001, d = 1.73$).

On the second manipulation check, we examined the degree to which participants perceived the continuation sentence congruent with their training condition to be a more fitting inference for the target scenario than the other continuation sentences. Mean ratings of the continuation sentences were submitted to a 2 (condition: NIC, PIC) by 2 (sentence type: target, foil) by 2 (sentence inferential style: negative,
positive) mixed design ANOVA. A main effect for sentence type was found, indicating that overall, participants rated target sentences as better continuations than foil sentences (Wilks’ Λ = .39, F(1,54) = 81.17, p < .001, η² = .61). Thus, participants’ answers reflected their inferences towards the displayed scenarios and were not merely affected by valence. Furthermore, as predicted, the three-way interaction between condition, sentence type and sentence inferential style was significant (Wilks’ Λ = .79, F(1,54) = 14.69, p < .001, η² = .21).

To explore the results pertaining to target sentences, mean ratings of these sentences were submitted to a 2 (condition: NIC, PIC) by 2 (sentence inferential style: negative, positive) mixed design ANOVA. The condition by sentence inferential style interaction was significant (Wilks’ Λ = .60, F(1,54) = 36.19, p < .001, η² = .40). Compared with participants in the NIC, those in the PIC rated the negative inferences target sentences as less fitting inferences (t(54) = 4.94, p < .001, d = 1.32), and the positive inferences target sentences as more fitting (t(54) = −4.21, p < .001, d = 1.12). Thus, participants’ preference for target sentences that reflect training-congruent inferences, points to the success of the training.

### Cognitive challenge

As expected, task accuracy was low (M = 14.46%), and all participants failed the task (scored under 50%). Training conditions did not differ in accuracy (t(43.53) = −1.02, p = .311, d = −.27). As predicted, participants in the NIC made more negative inferences concerning the failure on the RAT than did those in the PIC (t(55) = 2.67, p = .01, d = .69).

### State hope

Hope scores were submitted to a 2 (condition: NIC, PIC) by 2 (time: pre-training, post-cognitive challenge) mixed design ANOVA (see Figure 2(a)). As expected, the condition by time interaction was significant (Wilks’ Λ = .92, F(1,55) = 5.00, p = .029, η² = .08). Between group follow up analyses revealed no baseline differences between the experimental conditions (t(29) = 1.38, p = .178, d = .51). However, as predicted, post-cognitive challenge, those in the PIC had significantly higher hope scores compared to those in the NIC (t(55) = 2.31, p = .024, d = .62). Within group analyses revealed no change in hope following the cognitive challenge in either condition (t(28) = −1.77, p = .087, d = −.67 in the NIC and t(29) = 1.38, p = .178, d = .51 in the PIC).

### Mood

To examine the effects of the training and of the cognitive challenge on mood, mood scores were submitted to a 2 (condition: NIC, PIC) by 3 (time: pre-training, post-training, post-cognitive challenge) mixed design ANOVA (see Figure 2(b)). As predicted, the condition by time interaction was significant (Wilks’ Λ = .88, F(2,54) = 3.53, p = .036, η² = .12). Between group follow up analyses revealed that the experimental conditions did not differ at baseline (t(55) = −1.35, p = .181, d = .36). Despite the use of the filler task, immediately following the training, participants in the NIC reported lower levels of mood compared to those in the PIC (t(55) = −2.68, p = .01, d = −.72). Importantly, as predicted, this group difference was maintained following the cognitive challenge (t(55) = −2.36, p = .022, d = −.64).

### Table 2. Participants’ characteristics and results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>NIC (n = 28)</th>
<th>PIC (n = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>24.54 (2.13)</td>
<td>23.80 (2.18)</td>
</tr>
<tr>
<td>F/M</td>
<td>19/9</td>
<td>18/11</td>
</tr>
<tr>
<td>Mean levels of Trait measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASQ</td>
<td>4.16 (1.07)</td>
<td>3.86 (0.95)</td>
</tr>
<tr>
<td>Trait RSES</td>
<td>29.14 (3.91)</td>
<td>29.90 (3.71)</td>
</tr>
<tr>
<td>BDI-II</td>
<td>5.39 (2.91)</td>
<td>7.03 (4.19)</td>
</tr>
<tr>
<td>Training accuracy (% of correct answers)</td>
<td>83.56 (4.71)</td>
<td>87.73 (6.00)</td>
</tr>
<tr>
<td>Manipulation checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean percentage of probe items</td>
<td>57.72 (18.77)</td>
<td>29.94 (12.71)</td>
</tr>
<tr>
<td>attributed negatively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean scores of negative target sentences</td>
<td>3.00 (.48)</td>
<td>2.29 (.48)</td>
</tr>
<tr>
<td>Mean scores of positive target sentences</td>
<td>2.39 (.52)</td>
<td>2.92 (.42)</td>
</tr>
<tr>
<td>Mean scores of inferences towards the failure on the cognitive challenge</td>
<td>3.71 (.95)</td>
<td>3.10 (.79)</td>
</tr>
<tr>
<td>Mean scores on state measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-training</td>
<td>64.41 (18.81)</td>
<td>71.09 (18.48)</td>
</tr>
<tr>
<td>Post-training</td>
<td>61.8 (17.47)</td>
<td>74.12 (17.19)</td>
</tr>
<tr>
<td>Post-cognitive challenge</td>
<td>53.08 (19.15)</td>
<td>65.18 (19.54)</td>
</tr>
<tr>
<td>State hope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-training</td>
<td>6.02 (0.84)</td>
<td>6.26 (1.20)</td>
</tr>
<tr>
<td>Post-cognitive challenge</td>
<td>5.71 (1.08)</td>
<td>6.38 (1.11)</td>
</tr>
<tr>
<td>State RSES (negative)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-training</td>
<td>10.68 (11.12)</td>
<td>10.13 (10.28)</td>
</tr>
<tr>
<td>Post-training</td>
<td>14.60 (11.76)</td>
<td>9.51 (10.40)</td>
</tr>
<tr>
<td>Post-cognitive challenge</td>
<td>31.27 (21.75)</td>
<td>19.66 (14.81)</td>
</tr>
</tbody>
</table>

Note: NIC = Negative Inferences Condition; PIC = Positive Inferences Condition; F/M = number of female/male participants; NASQ = New Attributional Style Questionnaire; Trait RSES = Rosenberg Self-Esteem Scale; BDI-II = Beck Depression Inventory-II; State RSES = Resultant Self-Esteem Scale; standard deviations in parentheses.
Within group analyses in the NIC did not reveal a significant change in mood levels from pre to post training (t(28) = 1.62, p = .118, d = -.17), but a significant drop following the cognitive challenge (t(28) = -2.18, p = .038, d = .14), and a significant decrease following the cognitive challenge (t(28) = 3.39, p = .002, d = .47). Thus, the significant condition by time interaction was a result of mood changes in different directions following the training session – improved mood in the PIC and deteriorated mood in the NIC. This difference was maintained following the cognitive challenge.

**State negative self-esteem**

Negative self-esteem scores were submitted to a 2 (condition: NIC, PIC) by 3 (time: pre-training, post-training, post-cognitive challenge) mixed design ANOVA (see Figure 2(c)). As predicted, the condition by time interaction was significant (Wilks’ Λ = .82, F(2,54) = 5.93, p = .005, η² = .18).

Between group follow-up analyses revealed that the experimental conditions did not differ at baseline (t(55) = .19, p = .846, d = .05) or post training (t(55) = 1.73, p = .09, d = .47). However, as expected, following the cognitive challenge, participants in the NIC reported higher levels of negative self-esteem than did those in the PIC (t(55) = 2.36, p = .022, d = .64).

Within group analyses in the NIC revealed a significant increase in negative self-esteem from pre to post training (t(27) = 3.01, p = .006, d = .34) and from post training to post-cognitive challenge (t(27) = 4.91, p < .001, d = .95). In the PIC, there was no significant change in negative self-esteem from pre to post training (t(28) = .64, p = .527, d = .06) but there was a significant increase from post-training to post-cognitive challenge (t(28) = 3.85, p = .001, d = .79).

**Inferences for the cognitive challenge as a mediator of training effects**

We conducted mediational analyses using the procedures described by Preacher and Hayes (2008). In two separate analyses, we examined whether participants’ negative inferences concerning their failure on the cognitive challenge (RAT), mediated the effect of training condition on mood and state negative self-esteem following the cognitive challenge. Baseline levels of mood and negative self-esteem were entered as covariates to account for any initial group differences. Results based on 5,000 bias-corrected bootstrap resamples of the data indicated that the indirect effect of training on the change in participants’ mood and state negative self-esteem following the cognitive challenge was significant (IE = 3.90, SE = 1.80; 95% CI [1.17, 8.64]; IE = -5.67, SE = 2.43, 95% CI [-11.40, -1.58]; respectively). The total effect of the training condition on participants’ mood following the cognitive challenge was marginally significant (TE = 7.08, SE = 2.36, p = .056) and significant for
state negative self-esteem (TE = −11.14, SE = 4.31, \( p = .013 \)). However, after accounting for the indirect effects of training condition on participants’ negative inferences for the failure and their subsequent effect on mood and on negative self-esteem, the remaining direct effects of training condition on mood and on negative self-esteem were non-significant (DE = 3.17, SE = 3.54, \( p = .89 \); DE = −5.47, SE = 4.01, \( p = .179 \); respectively). These findings suggest that compared to participants in the PIC, those in the NIC made more negative inferences for their failure, and in turn, these inferences decreased their mood and increased their negative self-esteem (see Figure 3 for the mediation models and standardised coefficients).

**Discussion**

In the present study, participants completed a training session to enhance either a positive or a negative inferential style. Two different manipulation checks indicated that participants’ inferences both during and after the training, were congruent with their training condition and reflected training success in fostering a cognitive change. Consistent with our hypotheses and in line with the hopelessness theory, the training changed cognitions and affected mood and state self-esteem. Moreover, the success of the training was manifested in participants’ inferences for their failure on an unrelated task. Compared to participants in the PIC, those in the NIC made more negative inferences for their failure on the task. In turn, these inferences contributed to higher levels of negative mood and to lowered self-esteem. These findings provide support for the causal assumptions made by the hopelessness theory.

Our findings are in line with those of Peters et al. (2011), but add to their findings in several important ways. Our training did not target only stability and self-worth but targeted all the aspects of inferential styles. Our use of direct manipulation checks during and following the training session strengthens the conclusion that the training session indeed resulted in the desired cognitive change. The training also affected state hope. Furthermore, the training affected participants’ inferences for their failure on a subsequent task, which in turn, affected mood. These findings support the causal status of the assumptions made by the hopelessness theory. To date, there is a dearth of findings from experimental designs that directly manipulate inferences and reinforce causal inferences with findings from meditational analyses.

![Figure 3](image.png)

**Figure 3.** Models of the indirect effects of the training on mood (a) and negative self-esteem (b) following the failure on the cognitive challenge via the inferences for this failure. Baseline levels of mood and negative self-esteem were entered as covariates. Values presented are standardised regression coefficients. * \( p < 0.05 \); ** \( p < 0.001 \).
These findings join a growing body of CBM research in demonstrating the ability to modify cognitive biases. Most CBM studies have targeted the early stages of cognitive processes such as attention, memory or even interpretation. Inferences represent a later stage in cognitive processing. Being able to modify inferences using a short and simple training procedure is therefore, noteworthy. Furthermore, current CBM procedures have shown promise as clinical interventions mainly for anxiety, but effective procedures for depression are still in need. Further research targeting cognitive processes outlined by main cognitive theories of depression, such as the hopelessness theory, in clinical samples can continue the current work and fulfil this need.

Another aim of the current study was to investigate the proposed relationship between inferences and self-esteem as presented in the hopelessness theory. To the best of our knowledge, this study is the first to use an experimental manipulation of inferential style and its effect on state self-esteem. Previous studies have demonstrated the negative effect of failure on self-esteem (Park, Crocker, & Kiefer, 2007), but the present study emphasises that one's inferences for a failure affects self-esteem. The effect of internal attributions on self-esteem has been described in the original presentation of the hopelessness theory of depression (Abramson et al., 1989). According to the theory, depression caused by a negative inferential style accompanied by internal attributions is characterised by low self-esteem and dependency. In the current research, we demonstrated that inferential style affects self-esteem. Recent work emphasises that self-esteem is not merely a symptom or a consequence of depression but rather, it precedes it and may serve as a vulnerability factor that contributes to the onset of depression (e.g. Rieger, Göllner, Trautwein, & Roberts, 2016). Thus, it is possible that a negative inferential style affects depression partially via its effect on self-esteem. Testing this proposed link was not possible in the current research due to design limitations, and remains an interesting question for future research.

The current research has several limitations. First, the filler task we used did not fully neutralise mood, which resulted in a significant increase in mood among participants in the PIC immediately following the training phase. It could be argued that because mood was not neutralised following the training, the observed effects following the cognitive challenge may reflect training effects on mood rather than on inferences. However, because the training had a significant effect on cognitive change, which then affected mood and self-esteem, this alternative explanation is improbable. Another limitation concerns the assessment of hopelessness, for which we used a state measure of hope, due to lack of good measures of state hopelessness. Because the two constructs are not completely antithetical, caution in making conclusions concerning state hopelessness is needed. Furthermore, because we reasoned that state hope would be less sensitive to change (compared to mood and self-esteem), we did not measure it following the training, but only following the cognitive challenge. Indeed, following the cognitive challenge, the between-group difference was statistically significant but not the within-group change. Future research should assess state hope (or hopelessness) using a more sensitive measurement approach (perhaps by using a visual analogue scale rather than a Likert scale). Another limitation involves the analogue nature of the study – a single training session, using a lab-based failure induction in a sample of non-depressed participants. Evaluating changes in mood, hope and self-esteem over a longer period may be able to disentangle the training effects on these different outcomes. These features of the design may limit generalisation of the findings. Nevertheless, the scientific rigour afforded by an analogue study provides promise for future research to assess the effects of an inferential style CBM procedure in a more ecologically valid manner in a clinical sample.

The current study clearly demonstrates that a cognitive bias modification procedure can be successful in changing inferential style, at least for a brief period, and that this change affects sensitivity and resilience to failure. The results provide novel experimental and causal evidence in support of the hopelessness theory. They also point to the need to continue and include the effect of inferences on self-esteem as part of the causal chain described by the theory. Additionally, this study contributes to a growing body of research that examines CBM procedures that focus on main cognitive characteristics of depression. The current encouraging findings provide a promising direction in developing preventions and interventions that target depression.

Notes

1. Sample size was based upon previous similar studies (e.g., Peters et al., 2011) and results of a power analysis. In this analysis, we used a small effect size ($\eta^2 = 0.03$), $\alpha$-value of 0.05, power $1-\beta = .80$, and assumed correlation among repeated measures of 0.5. The required sample size was $n = 54$. 


2. The NASQ measure was selected over the CSQ due to time constraints. Although it does not assess inferences concerning consequences and self-worth, when combined with the random allocation to conditions, we think that a-priori group differences in inferential style are highly unlikely.

3. We used a measure of state hope as an approximate marker of state hopelessness due to the dearth of state measures of hopelessness.

4. Participants also completed a trait rumination measure, which is not relevant to the current study and therefore will not be reported.

5. The state questionnaires were also intermixed with a state rumination measure, which is not relevant to the current study and therefore will not be reported.

6. Factor analytic analyses indicated that the self-esteem measure consisted of separate factors of positive and negative self-esteem. Positive self-esteem scores were submitted to an analysis identical to that performed on negative items, but the condition by time interaction was non-significant (Wilks’ Λ = .96, F(2,54) = 1.09, p = .34, η² = .04). Therefore, follow up analyses were not conducted.

7. We have run a mediational analysis using state hope as a mediator, but did not find significant mediation. This null finding can be explained by the weak pre-post training effect found in hope.

Disclosure statement
No potential conflict of interest was reported by the authors.

References


