A brighter future: The effect of positive episodic simulation on future predictions in non-depressed, moderately dysphoric & highly dysphoric individuals

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Abstract

Previous research suggests depressed individuals have difficulties with future directed cognitions. For instance, compared with non-depressed individuals, they predict positive events are less likely to occur. Recent work suggests that episodic simulation of positive futures may represent a useful strategy for improving prospective predictions. The current studies investigated positive future episodic simulation as a method of modifying predictions regarding the likelihood of occurrence, perceived control, and importance of positive and negative future events. Experiment 1 compared positive episodic simulation to a neutral visualization task in a non-clinical sample. Predictions regarding future events were rated more positively after the use of positive episodic simulation but not as a result of neutral visualization. Experiment 2 extended these findings to show that future episodic simulation can be used to modify predictions, for both positive and negative events, in individuals experiencing significant levels of dysphoric mood and depressive symptoms. Taken together, these findings suggest that training in positive episodic future simulation can improve future outlook and may represent a useful tool within cognitive therapeutic techniques.

Keywords: future thinking, prospection, bias modification, mental time travel

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Major Depressive Disorder is characterised by low mood and diminished interest in daily activities (American Psychiatric Association, 2013). However, the symptoms of depression extend beyond both mood and motivation, incorporating a range of biases in thinking and behaviour. This has led to a number of cognitive models of depression (e.g. Abramson, Seligman, & Teasdale, 1978; Beck, 1967, 1988; 2008). Beck's model, arguably the most comprehensive of these theories, suggests that biased thought processes are a primary cause of depressive symptoms such as loss of motivation and self-criticism. Central to Beck's theory is a triad of negativity, whereby individuals hold negative views of the self, the world and the future. The latter of these, often termed prospection, has gained increasing research coverage in recent years, with a recent theoretical review by Roepke and Seligman (2016) arguing that prospection biases may lie at the heart of depressive thinking.

Prospection biases in depression and dysphoria

A burgeoning body of empirical literature supports the assertion that prospection biases exist in depression, with depressed individuals making biased predictions about the future. For instance, they tend to judge negative future events as more likely, and positive future events as less likely, to occur to themselves compared with other people (e.g. Pyszczynski, Holt, & Greenberg, 1987; Beck, Wenzel, Riskind, Brown, & Steer, 2006). Also, whilst depressed individuals report similar numbers of future goals as their non-depressed counterparts, and attribute similar levels of importance to them, they predict that these goals are less likely to occur and that they have less control over their occurrence (Dickson, Moberly, & Kindermann, 2011). Furthermore, they hold lower levels of hope with respect to future goals (Thimm, Holte, Brennen, & Wang, 2013). Depressed individuals also report greater ease of disengagement from unattainable goals and more difficulty re-engaging with new goals (Dickson, Moberly, O'Dea, & Field, 2016). Similar biases seem to be evident in non-clinical samples experiencing high levels of depressive symptoms, termed dysphoria. These studies suggest that high levels of depression and anxiety are both associated with increased predictions of the likelihood of negative future events.

However, only depression is associated with decreased predictions of the likelihood of positive events (Holmes, Lang, Moulds, & Steele, 2008; MacLeod & Byrne, 1996; Stober, 2000).

Biased predictions about future events could occur because depressed individuals have difficulty simulating vivid images of specific future events. Overgeneral future thinking, whereby individuals have difficulty mentally simulating events that could occur on one particular day, but instead focus on more general future-oriented experiences (categories of repeated events or events lasting longer than one day), has been evidenced in both depression and dysphoria (Anderson, Boland, & Garner, 2016; Dickson & Bates, 2006; Williams et al., 1996). Furthermore, a number of studies have suggested that clinical depression and high levels of dysphoria are both associated with difficulty generating vivid mental images; however, these studies suggest that this difficulty appears to be selective to positive prospective imagery (Holmes et al., 2008; MacLeod & Byrne, 1996; Morina, Deeprose, Pusowski, Schmid, & Holmes, 2011; Stober, 2000; Anderson & Evans, 2015; Szőllősi, Pajkossy, & Racsmány, 2015). Conversely, the ability to vividly engage in positive prospective mental imagery is positively associated with optimism (the dispositional generalized tendency towards positive expectancies about the future), a characteristic that has strong links with psychological well-being (Blackwell et al., 2013; Ji, Holmes, & Blackwell, 2017).

The difficulties that depressed individuals have with producing vivid images of positive future events are likely to impact on their ability to predict future success and, potentially, form a demotivating influence with respect to achieving future goals. This is because being able to vividly envisage a goal-relevant future event helps individuals plan behaviours and foresee potential obstacles in order to work towards desired goals (Taylor & Schneider, 1989). Szpunar, Spreng, and Schacter's (2014) integrative model of prospection argues that being able to vividly simulate future events may underlie an individual's ability to make positive predictions about the future, and form detailed and specific intentions and plans. Furthermore, diminished perceptions of control over life's events have been shown to link closely with feelings of helplessness and pessimistic expectancies within depression (see (Rubenstein, Alloy, & Abramson, 2016 for a review). Thus, difficulties with positive prospections are likely to tie closely with the pessimism and hopelessness that is characteristic of depression.

Training in positive future thinking

Training in positive episodic simulation could form a useful strategy for helping modify the biased beliefs that depressed individuals hold about their future. Research within the domain of experimental psychology suggests that training in episodic simulation and/or visual imagery can modify prospective predictions. For instance, imagining a future event increases the subjective likelihood of that event occurring (Carroll, 1978; Gregory, Cialdini, & Carpenter, 1982) and repeated mental simulation of a future event makes it seem more plausible (Szpunar and Schacter, 2013). One explanation for this is that the mental repetition of the event increases familiarity, and therefore increases its accessibility within memory. Additionally, it has been suggested that the formation of mental imagery may be a crucial component when using simulations to modify predictions (Holmes, Lang, & Shah, 2009)**.** In particular, mental imagery appears to have a stronger relationship with emotion than verbal processing (Holmes and Mathews, 2005).

Research has begun to explore the potential usefulness of mental simulation techniques, with imagery as a key element, for individuals experiencing depressed mood. McKinney, Antoni, Kumar, Times, and McCabe (1997) and Watanabe et al (2006) have reported significant decreases in depressive symptoms, and an increase in positive mood, after the use of guided imagery techniques. In addition, a study by Pictet, Coughtrey, Mathews, and Holmes (2011) found that repeated generation of positive prospective images in response to word-picture cues improved mood in a sample of dysphoric participants, and that these improvements in mood transferred to performance on an unrelated behavioural task. More recently, Renner, Ji, Pictet, Holmes, and Blackwell (2016) demonstrated that repeated generation of positive imagery boosts self-reported behavioural activation in depression. Similarly, Torkan et al., (2014) reported that repeated imagery for positive scenarios resulted in decreased depressive symptoms and reduced negative interpretive bias. Taken together, these findings provide support for the notion that positive mental imagery can be useful for improving mood. However, to date, no work has focused on whether positive episodic simulation can be used to modify the biased predictions that depressed individuals make about potential future events.

The present study

We present two studies that explore the role of episodic simulation as a method of modifying predictions about future events in both moderate and high dysphoria. In both studies we investigated whether positive episodic simulation impacts on a range of predictions regarding positive and negative future events. Based upon previous literature evidencing depressive biases in future goal-directed thinking (e.g. Dickson et al, 2011), our primary focus was on the potential modification of three predictive judgements: the individuals' belief that each event would happen to them (likelihood of occurrence); how important the event would be to them (importance); and how much control they would have over each event's occurrence (controllability). We also took ratings of vividness, as our secondary focus, due to research suggesting that the more vividly you imagine something, the more plausible it seems (Szpunar and Schacter, 2013). Experiment 1 recruited non-depressed participants to examine whether positive episodic simulation modifies these future event predictions from pre- to post-intervention, when compared with a control task (a neutral visualization task). Previous research has suggested that predictions, such as likelihood of occurrence, are modified by repeated simulation of events that are closely related in content (Szpunar and Schacter, 2013). Therefore, Experiment 1 also examined the extent to which the content of event predictions and the positive simulations needs to be conceptually related in order for prediction modification to be successful. This was achieved by comparing pre- and post-intervention change in predictions across related and unrelated positive simulation tasks, whereby the former contained simulation cues that were conceptually related, and the latter used cues that were unrelated, to the event predictions. Experiment 2 extended this to explore whether the same pattern of prediction modification occurs in individuals who are experiencing elevated levels of depressive symptomatology (moderate and high dysphoria).

Thus, in Experiment 1 we hypothesized that mentally engaging in positive episodic simulation would modify predictions about future events (from pre-simulation to post-simulation). In particular, we hypothesized that positive events would be appraised as more likely to occur, more controllable and more important post-intervention, compared to pre-intervention. We also hypothesised that positive events would become more vivid. If modifications of event predictions are reliant on the generation of conceptually related simulations, then one could expect these hypothesized changes to only occur following the episodic simulation of future scenarios in response to related cues. Furthermore, if conceptually related simulations are crucial for the purposes of bias modification, then positive simulation may have little impact on predictions regarding negative events. However, given that previous research has shown that positive prospective imagery can impact on unrelated behavioural tasks (e.g. Pictet et al, 2011), it is feasible that engaging in positive simulations about conceptually unrelated material may also impact on predictions about future events. Thus, positive future simulations in response to unrelated cues may also impact on predictions about positive future events in a similar way to simulations using related cues. Due to the lack of literature regarding modifying predictions regarding negative events, it was unclear what effect, if any, positive simulation would have on the negative future events. Finally, we theorised that it is the process of positive episodic simulation, rather than generic imagery engagement per se, that benefits predictions of future events. Thus, we hypothesized that no pre-to post-intervention change would be evident in future event predictions or vividness ratings for participants engaging in the neutral visualisation condition.

Experiment 1

Method

Participants. 63 participants (11 males) were recruited, with an age range of 18 to 51 years (*M* = 21.21, *SD* = 5.76). All were students from the University of Hull, participating in exchange for course credits. Informed consent was provided, with procedures approved by the Psychology Research Ethics Committee.

Materials.

Center for Epidemiologic Studies Depression Scale - Revised (CESD-R). The CESD-R (Eaton, Smith, Ybarra, Muntaner, & Tien, 2004) is a 20-item inventory used to assess the presence of depressive symptoms in nine different symptom clusters as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). The clusters are sadness (dysphoria), loss of interest (anhedonia), appetite, sleep, thinking/concentration, guilt (worthlessness), fatigue, movement (agitation) and suicidal ideation. Each item on the inventory is scored using a five point scale with respect to the extent the individual has experienced that symptom over the previous 1-2 week period*: 0 = Not at all or less than 1 day; 1 = 1 – 2 days; 2 = 3 – 4 days, 3 = 5 – 7 days; or 4 = Nearly every day for 2 weeks*. Summation of responses provides a total score between 0 and 80, with higher values indicative of increased depressive symptomatology. Additionally, using an algorithm provided by the scale authors, participants can be categorized according to DSM-5 criteria as follows: *symptoms of no clinical significance; subthreshold depression symptoms; possible major depressive episode; probable major depressive episode; or meets criteria for major depressive episode*. The CESD-R has demonstrated strong internal consistency across community samples (Van Dam & Earleywine, 2011).

Future Events Prediction Task. This task required participants to make predictions and vividness ratings about 30 events, 15 positive (e.g. people will admire you) and 15 negative (e.g. someone close to you will reject you) (Appendix A). For each event, participants predicted how likely it was to occur in the future, how much control they thought they had over the event occurring, how important the event was to them and rated how vividly they could see that event happening in their mind. Each prediction/rating was made on a 7 point scale (e.g. 0 = not at all likely and 6 = very likely). 25 of the events (15 negative and 10 positive) were taken from MacLeod, Byrne, and Valentine (1996), with the researchers devising a further 5 positive events, that were similar to MacLeod et al's, in order to have a balanced number of both positive and negative events. This task was presented using Opensesame Experiment Generator Software (Mathot, Schreij, & Theeuwes, 2012). Following an initial instruction screen, participants were presented with each event in turn; in each case, the event description was presented at the top of the screen with the four ratings scales on the lower half of the screen. Participants were instructed "you will be presented with 30 possible future events. For each event I would like you to rate them on: how likely you think that event will happen to you at any point in your future; how much control you feel like you would have over that event occurring; how important would that event be to your life story, if it were to happen; and how vividly can you picture that event happening". Presentation order of the 30 events was randomized across participants.

Future Simulation Task – Related Cues. This task, presented in OpenSesame, required participants to mentally simulate a series of positive future events as vividly as possible in response to the cue words provided. Each cue word appeared on the screen for 15s, followed by a 1s fixation dot, before the presentation of the next cue word. Each cue was size 45 Cambria (body) black font, contained in a white textbox, and centered on a black screen. The cues were derived from, and thus related to, the positive events used in the Future Events Prediction Task, with each positive event having a corresponding cue. For example, the event "people will admire you" corresponded with the cue word "admired" (Appendix B). Participants were instructed to imagine a single positive specific future event, as vividly as possible, that related to each cue word, and that some of the cue words might appear more than once. Participants were *not* instructed to close their eyes during, and indeed all participants kept their eyes open. They completed a practice block of 5 cue words prior to the experimental trials. Each cue word was presented twice hence a total of 30 experimental trials. Cue word presentation was randomized across participants.

Future Simulation Task – Unrelated Cues. This task was identical to the Future Simulation Task – Related, except that none of the cue words were derived from, or related to, any of the events in the Future Events Prediction Task. All cues were devised by the researchers (Appendix B).

Neutral Visualisation Task. This task, again delivered in OpenSesame, presented participants with a series of sentences as cues for a neutral visualization task. For each they were asked to visualize the described scene as vividly as possible. For example, "the layout of the local shopping centre" or "two birds sitting on a tree branch". The cues were a selection of 15 taken from a similar task used by Nolen-Hoeksema & Morrow (1993). Participants were instructed that they needed to visualise the scene presented and that some of the sentences might appear more than once. They received a practice block of 5 cue sentences prior to the experimental trials. Each cue was presented twice, with 30 experimental trials in total. Cue presentation was randomized across participants.

Jigsaw Task. The jigsaw was part of an app for the Ipad (Sparkle Apps, 2014) and comprised 120 pieces. Participants had to move the pieces into place with their finger from the bottom of the screen, and were given 15 minutes to complete as much of the jigsaw as possible.

Design. A 3 (Intervention Task: Related Simulation vs. Unrelated Simulation vs. Neutral Visualisation) x 2 (Valence of Prediction Event: Positive vs. Negative) x 2 (Time: Pre- vs. Post-intervention) was employed, with repeated measures on the final two factors. Participants were randomly assigned to one of the three experimental intervention tasks. Dependent variables were the predictions/ratings made by participants regarding future events within the Future Events Predictions Task (likelihood of occurrence, controllability, importance, and vividness).

Procedure. Participants were tested individually with the researcher present. The computerized experimental tasks were presented on a Macbook. After providing informed consent, participants completed the Future Events Predictions Task. Participants were then distracted from thinking about the events presented in this initial task for 15 minutes. During this time they completed the Jigsaw Task and the CESD-R. Participants then either completed the Future Simulation Task - Related or - Unrelated, or the Neutral Visualization Task and, finally, they completed the Future Events Predictions Task for a second time.

Results

Participant Demographics. To ensure that the demographics of the participants assigned to the three experimental tasks did not differ, two separate one-way ANOVAs established that neither age, $F(2,62) = .72$, $p = .49$, nor CESD-R score, $F(2,60) =.52$, $p = .60$, differed across the three sets of participants.

Baseline Differences Between Intervention Task Conditions. In order to establish whether there were any between-condition differences in participants' predictions/ratings at baseline (pre-invention), four separate one-way ANOVAs were conducted. No significant differences were found for any of the four variables (likelihood, control, importance and vividness; Fs < 1.00, ps > .37).

Changes in Future Event Predictions. The change in each event prediction (likelihood, controllability, and importance) was analysed using a 2 (Time: pre- vs. post-intervention) x 2 (Valence of Prediction Event: positive vs. negative) x 3 (Intervention Task: related vs. unrelated vs. neutral) mixed ANOVA, with repeated measures on the first two factors. Bonferroni adjusted pairwise comparisons were conducted, where required, to clarify the nature of significant effects. Descriptive statistics are displayed in Table 1.

Likelihood. Significant main effects emerged for both time, $F(1,60) = 4.91$, $p = .03$, $\eta p^2 =.08$, and valence of prediction event, $F(1,60) = 123.40$, $p <.001$, $\eta p^2 = .67$, with events being predicted as more likely pre-simulation and positive events predicted to be more likely to happen compared with negative events. However these two main effects were qualified by a significant interaction, $F(1,60) = 95.48$, $p < .001$, $\eta p^2 = .61$. Pre- to post-intervention changes showed that positive events were rated as more likely to happen ($p < .001$), whilst negative events less likely to happen ($p <.001$), post-simulation.

There was no significant main effect for intervention task, nor did intervention task interact significantly with time or valence of prediction event

(Fs $\leq$ 1.35, ps $\geq$ .27, ηp^2 s $\leq$ .04). However, a significant three-way interaction did emerge, $F(2,60) = 20.62$, $p < .001$, $\eta p^2 = .41$. Both the positive future simulation tasks (related and unrelated) led to a significant increase in likelihood predictions for positive events pre-to post-intervention ($p < .001$) and a significant decrease in likelihood predictions for negative pre-to post-intervention ($p < .001$). However, the neutral visualization task led to no significant pre- to post-intervention change in likelihood predictions for positive events ($p = .61$) or negative events ($p = .21$).

Controllability. Significant main effects of time, $F(1,60) = 5.35$, $p = .02$, $\eta p^2 = .08$, and valence of prediction event emerged, $F(1,60) = 187.82$, $p < .001$, $\eta p^2 = .76$, with events being perceived as more controllable post-intervention and positive events predicted to be more controllable compared with negative events. These main effects were also qualified by a significant interaction, $F(1,60) = 10.10$, $p = .002$, $\eta p^2 = .14$. There was a significant increase in perceived control over positive events pre-to post-intervention ($p < .001$), however there was no significant difference in perceived control over negative events pre-to post-intervention ($p = .88$).

There was no significant main effect of intervention task, $F(2,60) = .07$, $p = .93$, $\eta p^2 = .00$, although a trend towards significance emerged for Time x Intervention Task, $F(2,60) = 3.13$, $p = .051$, $\eta p^2 = .09$. There was a significant increase in perceived control pre-to post-intervention for future simulation task-related ($p = .001$), however there was no significant difference found for either the future simulation task-unrelated ($p = .67$), nor the visualization task ($p = .83$). There was also a trend towards significance for the three-way interaction, $F(2,60) = 2.94$, $p = .06$, $\eta p^2 = .09$. There was a significant increase in perceived control over positive events pre-to post-intervention in both positive future simulation tasks ($p < .001$ & $p = .005$ respectively). In regard to the negative events, there was a trend towards a significant increase in perceived control pre-to post-intervention for the future simulation task-related ($p = .058$), but no significant difference in the future simulation task-unrelated ($p = .13$). Regarding the future visualization condition, there was no significant difference for perceived control over either positive events ($p = .54$) or negative events ($p = .89$) pre-to post-intervention.

Importance. A main effect of valence of prediction event emerged, $F(1,60) = 86.32$, $p < .001$, $\eta p^2 = .59$, with positive events being rated as more important compared with negative events. No main effect emerged for time, $F(1,60) = .002$, $p = .97$, $\eta p^2 = .00$. However this was qualified by a significant interaction, $F(1,60) =$

26.13, $p < .001$, $\eta p^2 = .30$. There was a significant increase in predictions of importance for positive events pre-to post-intervention ($p < .001$) and a significant decrease in importance predictions for negative events pre-to post-intervention ($p = .008$).

There was also a significant three-way interaction, $F(2,60) = 5.95$, $p = .004$, $\eta p^2 = .17$. For both the positive future simulation tasks, there were significant increases in predictions of importance for positive events (*p*s = .001 & .02 respectively), and trend towards/a significant decrease in importance predictions for negative events (*p*s = .07 & .001 respectively) pre-to post-intervention. In the visualization task, there was no significant difference in predictions of importance for either positive ($p = .32$), or negative, events ($p = .62$) pre-to post-intervention.

There were no other significant main effects or interactions (*F*s ≤ 1.49, *p*s ≥ .23, ηp^2 s ≤ .05).

Changes in Vividness Ratings. A further 2 (Time) x 2 (Valence of Prediction Event) x 3 (Intervention Task) mixed ANOVA assessed participants' vividness ratings. A significant main effect emerged for valence of event prediction, $F(1,60) = 100.67$, $p < .001$, $\eta p^2 = .63$, with positive events rated as more vivid compared with negative events. No main effect of time emerged, $F(1,60) = .36$, $p = .55$, $\eta p^2 = .01$. However there was a significant interaction between time and valence of event prediction, $F(1,60) = 43.28$, $p < .001$, $\eta p^2 = .001$, with an increase in vividness ratings for positive events ($p < .001$) and a decrease in vividness ratings for negative events ($p < .001$) pre-to post-intervention. No significant main effect of intervention task emerged, $F(2,60) = .18$, $p = .84$, $\eta p^2 = .01$, nor was there a significant interaction between valence of event prediction and intervention task, $F(2,60) = 1.81$, $p = .17$, $\eta p^2 = .06$. There was, however, a significant three-way interaction, $F(2,60)=9.58$, $p < .001$, $\eta p^2 = .24$. In both the positive future simulation tasks, there was a significant increase in vividness ratings for positive events (*p*s <.001) and a significant decrease in vividness ratings for negative events (*p*s < .001& .04 respectively) pre-to post-intervention. There was no significant pre- to post-intervention change in vividness ratings for either the positive (p=.16), or the negative, events (p=.98) in the neutral visualization condition.

Discussion

Consistent with our hypotheses, predictions about event likelihood and vividness ratings increased for positive, and decreased for negative, events post-simulation following both the related and unrelated cue-word future simulation tasks. With regard to predictions of perceived control, partial support for our hypotheses emerged. Perceived control over both positive and negative events increased following the related cue simulation task. However, following the unrelated cue simulation task, whilst perceived control for positive events increased, there was no change in predictions for negative events. Finally, in line with our hypothesis, predictions of importance increased for positive events following both the related and unrelated cue simulation tasks. Interestingly, importance predictions for negative events decreased post-simulation following both of these tasks, which we did not explicitly hypothesize. This could be linked to the fact that both likelihood and vividness ratings increased for positive events and decreased for negative events; if these events are more/less vivid and more/less likely then they may also seem more/less important. Most importantly, these changes in predictions about future events following the simulation tasks were not mirrored following completion of the neutral visualization task. This suggests that the effects are a function of positive episodic simulation rather than merely engaging in imagery *per se*.

There were two surprising findings. First, the pattern of findings was similar for both related cue-word and unrelated cue-word simulation tasks. Second, predictions and ratings about negative future events were modified despite participants only simulating events from positive cues. Previous work by Szpunar and Schacter (2013) has suggested that an individual needs to simulate a specific, or closely related, event for that event to then seem more plausible. However, our findings suggest that positive episodic simulations using unrelated cue words were equally effective in modifying predictions about both positive and negative future events. One explanation for this is that the process of positive episodic simulation temporarily modifies participants' optimistic orientation, whereby their generalised expectancies about the future become more positive, rather than purely impacting predictions about events related to the simulations themselves. This in line with previous research suggesting that optimistic orientation can be temporarily manipulated by using imagery-based techniques within an experimental setting (Fosnaugh, Geers, & Wellman, 2009; Peters, Flink, Boersma, & Linton, 2010).

Following the promising findings of Experiment 1, we set out to assess whether positive future simulations can be used to modify biases evident in individuals experiencing high levels of depressive symptomatology. We used the

Future Simulation Task from Experiment 1, but limited it to related cue words only. This allowed us to assess Szpunar & Schacter's (2013) idea that repeated simulation leads to participants rating events as more plausible. We employed this task across three groups of participants who differed as a function of depression status. Using the algorithmic method of scoring the CESD-R (Eaton et al, 2004), the first group met criteria for major depressive disorder or probable major depressive disorder (high dysphoria), whilst the second were experiencing sub-clinical levels of depression (moderate dysphoria). A third group of non-depressed controls also participated for comparison purposes. If positive simulations are to form part of a useful toolkit for bias modification then pre- to post-intervention changes in event predictions need to be evidenced in both the moderate and high dysphoria groups.

A secondary aim of Experiment 2 was to examine the impact of repeated simulation on predictions regarding future events. Earlier experimental research (e.g. Szpunar & Schacter, 2013) has placed emphasis on the process of *repeated* simulations for the purposes of increasing plausibility of those future events. Although we found that both related and unrelated positive simulations functioned similarly in Experiment 1, it is possible, however, that positive simulations may prove even more beneficial when they are repeated multiple times. Thus, in order to test this assertion, we modified the method used in Experiment 1 so that some cues were presented 5 times, some were presented once, and some did not appear at all. This allows us to assess whether repeated simulation of related events enhances bias modifications. Based on Szpunar & Schacter's (2013) findings we hypothesized that events with a related cue word simulated multiple times (five) would lead to higher likelihood, controllability and importance predictions and vividness ratings for positive events, compared to a single simulation of a related cue word, or simulation of no related cue words. With respect to negative events, we hypothesized that, similar to Experiment 1, simulation would lead to an increase in ratings of perceived control but a decrease in likelihood and importance predictions and vividness ratings from pre- to post-simulation.

Experiment 2

Method

Participants. 104 undergraduates from the University of Hull (24 males), with an age range of 18 to 56 years (M = 21.20, SD = 5.36), participated in exchange for course credits or a small payment. All participants provided informed consent and the procedures were approved by the Psychology Research Ethics Committee.

Participants' current depression status was established based on their profile on the CESD-R (Eaton, et al., 2004). Participants were also asked to self-report any current, or previous, treatment for depression. 8 participants met criteria for major depressive episode and 16 for probable major depressive episode. These 24 participants formed the *high dysphoria* group; three of these participants were currently receiving treatment for depression, whilst seven reported treatment within the past year and a further six had received treatment over a year ago. A further 35 participants met criteria for subthreshold depression symptoms and formed a second, *moderate dysphoria* group. Within this group, no participants were currently in receipt of treatment for depression, although nine reported treatment within the past year and four had received treatment over a year ago. Finally, 45 participants reported symptoms of no clinical significance. However, seven of these participants reported receiving treatment for depression in the past. On this basis their data was excluded from further analyses and the remaining 38 participants formed the *non-depressed* control group. No participants met criteria for possible major depressive episode.

Materials. The CESD-R (Eaton et al, 2004), Future Events Prediction Task, and Jigsaw Task were identical to Experiment 1. The Future Simulation – Related Cues Task was modified to investigate the effect of repeated simulation. Five cues were presented 5 times, five cues were presented once, and five cues were not presented at all, hence there were 30 simulations in total. Which cues were presented five times, once, or not at all, was randomized across participants, as was the presentation order of the cues.

Design. A 3 (Depression Status: non-depressed vs. moderate dysphoria vs. high dysphoria) x 2 (Valence of Prediction Event: positive vs. negative) x 2 (Time: pre- vs. post-intervention) was employed, with repeated measures on the final two factors.

Additionally, the repetition of simulation cues (related to positive events only) was also manipulated within subjects (five presentations vs. one presentation vs. no presentation). The dependent variables were identical to those used in Experiment 1.

Procedure. The procedure was identical to that of Experiment 1.

Results

Participant Demographics. Two separate one-way ANOVAs established that there was no significant differences in age across the three sets of participants, $F(2,96) = 78.90$, $p = .06$. However, the three groups differed significantly with respect to CESD-R scores, $F(2,96) = 182.46$, $p < .001$. The high dysphoria group scored significantly higher compared with both the moderate dysphoric and non-depressed groups; additionally, the moderate dysphoric group scored significantly higher than the non-depressed control group (all *p*s < .001).

Changes in Event Predictions. Changes in each prediction (likelihood, controllability, importance) were analysed using three separate 2 (Time: pre- vs. post-simulation) x 2 (Valence of Prediction Event: positive vs. negative events) x 3 (Depression Status: non-depressed vs. moderate dysphoria vs. high dysphoria) mixed ANOVAs. Bonferroni adjusted pairwise comparisons were then conducted, where necessary, to elucidate on any significant effects. Descriptive statistics are displayed in table 2.

Likelihood. Significant main effects emerged for time, $F(1,94) = 36.60$, $p < .001$, $\eta p^2 = .28$, and valence of prediction event, $F(1,94) = 18.18$, $p < .001$, $\eta p^2 = .16$. Likelihood predictions were higher pre-intervention and positive events were predicted as more likely to occur than negative events. These main effects were also qualified by a significant interaction, $F(1,94) = 189.82$, $p < .001$, $\eta p^2 = .67$. A significant elevation occurred in likelihood ratings for positive events from pre- to post-intervention ($p < .001$). Conversely, likelihood ratings for negative events evidenced a significant decline from pre-to post-intervention ($p < .001$).

Neither the main effect of depression status, $F(2,94) = 1.03$, $p = .36$, $\eta p^2 = .02$, nor the Depression Status x Time interaction, $F(2,94) = 2.64$, $p = .08$, $\eta p^2 = .05$, were significant. However, the Depression Status x Valence interaction was significant, $F(2,94) = 27.22$, $p < .001$, $\eta p^2 = .37$. Both the non-depressed and moderate dysphoric participants predicted positive events as more likely to occur than high dysphoric participants ($p =. 001$). Likelihood predictions for positive events did not differ between the moderate dysphoric and non-depressed participants ($p = .11$). Additionally, the non-depressed participants predicted negative events as less likely than both the moderate dysphoric ($p = .004$) and the high dysphoric ($p < .001$) participants, and the moderate dysphoric group predicted negative events as significantly less likely to occur than the high dysphoric group ($p = .04$). A significant three-way interaction also emerged, $F(2,94) = 6.11$, $p = .003$, $\eta p^2 = .12$ (Figure 1).

The non-depressed individuals predicted positive events as significantly more likely to occur than negative events; a pattern evident both pre- and post- intervention (*p*s $< .001$). However, high dysphoric participants showed the reverse pattern pre-intervention, predicting negative events as significantly more likely to occur than positive events ($p < .001$). Post-intervention they evidenced no difference in likelihood predictions for positive and negative events ($p = .56$). Furthermore, moderate dysphoric participants evidenced no difference in the perceived likelihood of positive and negative events pre-intervention ($p = .57$), yet they reported positive events as significantly more likely to occur post-intervention ($p < .001$).

Controllability. Significant main effects emerged for time, $F(1,94) = 16.31$, $p < .001$, $\eta p^2 = .15$, valence of prediction event, $F(1,94) = 258.52$, $p < .001$, *ηp2* = .73, and depression status, $F(2,94) = 7.67$, $p = .001$, $\eta p^2 = .14$. Participants reported higher levels of control post-, compared with pre-intervention, with positive events predicted as more controllable than negative events. Both non-depressed and moderate dysphoric participants perceived events to be more controllable compared to the high dysphoric participants ($p = .001$ and $p = .05$ respectively). No differences emerged in perceived control between the non-depressed and moderate dysphoric participants ($p = .37$).

A significant Time x Valence of Prediction Event interaction was evident, $F(1,94) = 4.52$, $p = .036$, $\eta p^2 = .05$. A highly significant pre- to post-intervention increase in perceived control was evident for positive events ($p < .001$), and for negative events ($p = .004$). No other interaction effects were significant (*F*s ≤ 2.76, *p*s $\geq .07$, ηp^2s $\leq .06$).

Importance. A significant main effect emerged for Valence of Prediction Event, $F(1,94) = 118.35$, $p < .001$, $\eta p^2 = .56$, but not for time, $F(1,94) = .19$, $p = .66$, $\eta p^2 = .00$, Positive events predicted as more important compared with negative events. However, these effects were qualified by a significant Valence of Prediction Event x Time interaction, $F(1,94) = 12.80$, $p = .001$, $\eta p^2 = .12$. Importance predictions for positive events increased pre-to post-intervention (p = 0.31) and importance predictions for negative events decreased from pre- to post-intervention ($p = .036$).

The main effect of depression status was not significant, $F(2,94) = .08$, $p = .92$, $\eta p^2 = .00$, and all other interaction effects were not significant (*F*s ≤ .1.59, *p*s ≥

.21, $\eta p^2 \leq .03$). Thus, the effects of intervention on the importance of future event predictions did not differ as a function of depression status.

Changes in Vividness Ratings. A further 2 (Time) x 2 (Valence of Prediction Event) x 3 (Depression Status) mixed ANOVA assessed vividness ratings. A significant main effect emerged for valence of prediction event $F(1,94) = 26.99$, $p < .001$, $\eta p^2 = .22$, with positive events rated more vivid compared with negative events. Whilst no significant main effect of time was found, $F(1,94) = .03$, $p = .86$, $\eta p^2 = .00$, a significant Valence of Prediction Event x Time interaction did emerge, $F(1,94) = 49.42$, $p < .001$, $\eta p^2 = .35$. There was a significant increase in vividness ratings for positive events from pre- to post-intervention ($p < .001$), and a significant decrease in vividness ratings for negative events pre-to post-intervention ($p < .001$).

Neither the main effect of depression status, $F(2,94) = 1.19$, $p = .31$, $\eta p^2 = .03$, nor the Depression Status x Time interaction, $F(2,94) = .04$, $p = .83$, $\eta p^2 < .00$, were significant. However, other significant interactions involving depression status did emerge. Firstly, there was a significant Depression Status x Valence of Prediction Event interaction, $F(2,94) = 29.62$, $p < .001$, $\eta p^2 = .39$. Non-depressed participants rated positive events significantly more vivid, and negative events as significantly less vivid, compared to the high dysphoric participants (ps $\geq .002$). Trends towards significance suggest that a similar pattern was evident between the non-depressed and the moderate dysphoric participants (ps = .07). No significant difference emerged between high dysphoric and moderate dysphoric participants with respect to the vividness of positive events ($p = .48$), yet high dysphoric participants rated negative events as more vivid than their moderate dysphoric counterparts ($p = .009$). No three-way interaction emerged $F(2,94) = 1.61$, $p = .21$, $\eta p^2 = .03$.

Effects of Repeated Simulation. The secondary aim of this study was to examine the influence of repeated simulation on prediction/rating modification. As negative events were not simulated, these analyses focused only on predictions and vividness ratings for positive events. Thus, four separate 3 (Repetition) x 2 (Time) x 3 (Depression status) mixed ANOVAs were conducted on the likelihood, control, importance and vividness ratings for positive events. Descriptive statistics are displayed in Table 3. Pre- to post-intervention changes in predictions/ratings about positive events as a function of depression status have already been explored in the previous analyses, thus of particular interest here were any significant Repetition x Time or three-way interactions. No such interactions emerged (Fs ≤ 2.76, $ps \geq .07$, ηp^2s

$\leq .15$). Repeatedly simulating positive events did not impact on likelihood, controllability, or importance predictions, nor the vividness ratings of related events.

Discussion

Experiment 2 extended the findings of Experiment 1 by examining whether positive episodic simulation can be used to modify predictions and ratings regarding positive and negative future events in individuals experiencing moderate and high levels of dysphoria.

Consistent with our hypotheses, pre- to post-intervention changes showed that likelihood, vividness, and importance ratings increased for positive, and decreased for negative, events. Furthermore, predictions of perceived control increased for both positive and negative events post intervention. These intervention changes were found for all three depression status groups. Some effects of depression status did emerge. It is evident that both groups of dysphoric, compared with the non-depressed, participants, rated positive events as less, and negative events as more, vivid, likely to occur, and important. They also rated all events as less controllable. These biases were evident at pre- and post-intervention. These effects provided further evidence of the biases in predictions and ratings about future events that are evident in moderate and high dysphoria. However, crucially, they did not show a different pattern of pre- to post- intervention change as a function of depression status. As a function of the intervention, both dysphoric groups showed significant increase in predictions/ratings of likelihood, importance, and vividness for positive events. Conversely, they showed decreases in these predictions/ratings for negative events. In addition, both dysphoric groups evidenced higher levels of perceived control for both positive and negative events.

The secondary aim of the experiment was to explore the effect of repeated simulation of related events on future event predictions and ratings. The hypothesis regarding repeated simulation was not supported; we found no effect of repetition. Events that were simulated 5 times or once were not rated any different post-intervention to events that were not simulated. This finding does not extend the findings from Szpunar & Schacter (2013) who found multiple simulations increased plausibility ratings. This provides further support for our suggestion that the pre- to post-intervention improvements evidenced within these studies may be a function of a general increase in optimism.

General Discussion

The two experiments detailed here have shown that positive future episodic simulations can alter the predictions and ratings individuals make about positive future events. This is in line with other research showing that simulating events makes them appear more plausible (Szpunar & Schacter, 2013; Sherman, Cialdini, Schwartzman, & Reynolds, 1985; Anderson, 1983). Interestingly, positive future episodic simulations also impacted on predictions and ratings made about negative future events. We did not explicitly predict that this would happen. Nevertheless, it is interesting to note that engaging in a positive simulation task not only affects the prospect of positive events, but also affects how individuals view potential negative events. Furthermore, our findings regarding repeated simulation suggest that the effects of episodic simulation may not only concern the events that are simulated, but generalize across other events too. This is in contrast to previous literature showing changes in event appraisals only for events that were repeatedly simulated (eg. Szpunar & Schacter, 2013). One possible explanation for our findings is that a temporary increase in optimistic orientation is responsible for the prediction/rating changes across both positive and negative future events. Thus, the individuals' general expectancies about the future are temporarily modified – an idea consistent with research showing that experimental manipulations evoking positive imagery lead to increased optimism (Fosnaugh et al, 2009; Peters et al, 2010). Furthermore, other work has shown that the effects of imagery techniques on optimism can be successfully incorporated into interventions across a longer duration (Meevissen, Peters, & Alberts, 2011). Optimism is a characteristic that has strong links with psychological well-being, and others have already posited that increasing the vividness of positive prospective mental imagery may serve as a mechanism for improving optimism (Blackwell et al, 2013; Ji et al, 2017). Thus, our findings potentially lend further support to this assertion and suggest that empirical work specifically investigating the impact of positive episodic simulation training on measures of optimism would be an avenue worthy of further investigation.

Importantly, the pre- to post-intervention changes in future event predictions and ratings occurred across all three depression status groups. Thus, our results suggests that, through the process of simulating positive future episodes, both moderate and high dysphoric individuals' future-directed prediction and rating biases can be altered. They are able to imagine positive future events as more vivid, likely to happen, important, and controllable following a short positive episodic simulation training intervention. Conversely, they rate negative events as less vivid, likely to happen and important following this intervention. They also rate these negative events as more controllable post-intervention.

The difficulty that dysphoric individuals have with positive future cognitions would likely impact on their ability to foresee future success. Furthermore, it could have a demotivating influence with respect to achieving future goals. Our finding that, post simulation, highly dysphoric individuals rate positive future events as more likely to happen and as more controllable is important as it suggests that engaging in positive imagery could be used to increase motivation to achieve goals. When asked to generate important goals, depressed individuals produce similar numbers of goals to non-depressed individuals, but they produce goals that are less specific and have less specific explanations for why or how they would attain that goal. This suggests that some of the motivational deficits that can be seen in depression could partly be due to the reduction in the specificity of personal goal representation and the cognitions that support goal directed behavior (Dickson & Moberly, 2013; Dickson, Moberly, & Kindermann, 2011). Personal goals are important as they can provide the motivation an individual needs in order to enact problem solving behaviors (Oettingen & Mayer, 2002). In addition, they are important for organizing long-term behavior and for providing meaning in life (Dickson & Moberly, 2013) . In future research it would be interesting to see if simulation techniques similar to those reported here could have an impact in making personal goals more realizable for depressed individuals.

Beck's original cognitive therapy (1976) stresses the importance of assessing patient's images, as well as their verbal thoughts. However, Roepke and Seligman (2016) argue that much of cognitive therapy appears to be focused on verbal thoughts regarding the past. Thus, the focus on imagery may have been somewhat neglected. A focus on verbal thoughts could lead both patients and therapists to miss other cognitive processes that may be beneficial in the treatment of depression. It has been suggested that promoting verbal thoughts in cognitive therapy may not have as much impact on positive mood as promoting positive imagery, and may even lead to a reduction in positive mood (Holmes, Mathews, Dalgleish, & Mackintosh, 2006). The current study suggests that, if explicitly instructed to generate positive mental imagery, highly dysphoric individuals can benefit with regards to their future outlook.

Past research has demonstrated the negative effect that positively valenced material can have on depressed individuals (eg. Joormann et al., 2007), therefore it may be crucial to use strict time constraints and clear instructions in order for depressed people to engage with positive mental imagery, and not drift off into rumination. Thus, together with previous work (e.g., Holmes et al., 2006; Pictet, Coughtrey, Mathews, & Holmes, 2011), the current study highlights the utility of imagery for positive affect, future outlook, and motivation.

Some methodological issues with the present study necessitate caution when drawing conclusions from our data. First, while the current study highlights the potential utility of mental imagery for prediction and rating modification, we had little control over what people actually imagined in the simulation task. It is difficult to know whether participants completed the tasks in the same way, whether instructions were followed as directed, and the nature of the images they created. It is possible that, whilst some participants were focused on the task, others may not have been, or may even have been distracted by their own thoughts. It is also a possibility that, in Experiment 1, participants in the unrelated simulation condition actually engaged in related simulations by employing images of events from the predictions task. Although we have no independent evidence to suggest participants did this, nonetheless future researchers should aim to gain insight into the specific content of people's images to clarify these issues. A related concern from Experiment 1is that, unlike some other studies (e.g. Holmes, et al, 2006; Pictet et al, 2011; Torkan et al, 2014), we did not obtain ratings of the phenomenological characteristics of participants' simulations during the intervention stage (e.g. vividness, sensory detail, emotionality). Thus, we cannot be certain that the images generated across different related and unrelated simulations were comparable and significantly different from those within the neutral visualization condition. Consequently, we cannot rule out the possibility that the modifications evidenced in the related and unrelated simulation conditions were a function of participants engaging in more vivid and detailed visual imagery when simulating positive, compared with neutral, events (Szpunar & Schacter, 2013). Additionally, in Experiment 2, it might have been useful to obtain ratings, such as vividness, during the intervention stage to reveal any potential differences in simulation abilities between depression status groups. Future researchers should perhaps obtain baseline measures of individual differences in imagery ability, using a measure such as the Vividness of Visual Imagery Questionnaire (Marks, 1973).

Second, an additional measure that could benefit future work would be the inclusion of pre- and post-intervention measures of state mood. This would allow us to assess whether mood change drives our observed modifications. Furthermore, it would help rule out the possibility that variations in participants' state mood could explain why no differences were found between the related and unrelated simulation conditions in Experiment 1, and no effect of repetition was found in Experiment 2. Additionally, administering the CESD-R immediately prior to the intervention task could have primed mood and/or weakened the positive simulation manipulation. Thus, future research should include measures of state mood, administer the CESD-R at a different point in the procedure, and include a filler task prior to the final prediction task. The latter would help equalise mood across the different conditions and further rule out any potential explanation that the effects we found are simply a reflection of differences in state mood. The role of state mood changes as a driving factor in the observed prediction/rating modifications could also be ascertained by a follow-up study in which a different intervention task, that induces a positive mood via non-imagery based mechanisms (e.g. listening to positive music, completing a positive verbal task), was used as a comparator against our imagery-based positive episodic simulation task.

Third, the current research relies on self-reported measures of predictions about future events. Given the limitations inherent in self-report measures, it would be beneficial if future research could incorporate implicit measure of future expectancies and/or future-oriented behavioural tasks.

Fourth, the present study did not include any additional follow-up assessment to examine the longevity of the changes. It would be of interest to see whether, after a single intervention, the effects maintain or whether, in order to maintain the effects seen, continued practice of the simulation task is necessary. This may be paramount to the success of using positive imagery within therapy, as determining the lasting effects of this simulation task on depressed individuals will ultimately reveal the long-term effectiveness; in turn this would allow professionals to establish how frequently such an intervention should be carried out to ensure lasting results. Furthermore, replicating the study in a clinically diagnosed depressed sample would allow us to determine whether the intervention has similar effects in a clinical group – necessary and important for developing a therapeutic tool. Finally, research suggests that higher levels of vividness and likelihood ratings for negative events are generally more strongly associated with anxiety, rather than depression (eg. Morina et al., 2011), therefore it would be of interest to see if the same modification intervention reduces state anxiety.

In summary, we have shown that, by simulating positive future events, participants appraise them as more likely to occur, more vivid, controllable and important. They also appraise negative events as less likely to happen, less vivid, perceive greater control over them, and feel like they are less important after simulation. This was true for a non-depressed group, a moderately dysphoric group, and a highly dysphoric group. These findings demonstrate that dysphoric individuals' appraisals of future events can be modified through a positive simulation task – a finding of special relevance to cognitive therapy. Further research is now necessary to determine whether or not the effects observed in the present study can be maintained after the initial simulation task is complete, or whether repeated simulations are necessary. The current findings have given us some insight into the effect of simulating positive future events in dysphoria, and is further evidence for the beneficial use of imagery in the treatment of dysphoria.

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Appendix A

Positive Prediction Events
1. People will admire you
2. You will have lots of energy
3. You will do well on your course
4. You will achieve things you set out to do
5. You will be very fit and healthy
6. You will have lots of good times with friends
7. You will be able to cope easily with pressure
8. People you meet will like you
9. You'll make good and lasting friendships
10. Your mind will be alert and "on the ball"
11. You will receive some good news
12. You'll make a good decision
13. You will receive praise from someone
14. Things will work out as you hoped
15. You will be able to solve a problem

Negative Prediction Events
1. You will have a serious disagreement with a good friend
2. You will feel misunderstood
3. You will get the blame for things going wrong
4. Someone close to you will reject you
5. Things won't work out as you hoped
6. People will dislike you
7. People will find you dull and boring
8. People will think you're a failure
9. You'll be excluded by friends
10. You'll make lots of mistakes
11. You will be unable to confide in anyone
12. You will become tired and lethargic
13. People will make fun of you
14. You will let someone close to you down
15. You will be unable to cope with your responsibilities

Appendix B

Related Cue Words
1. Admired
2. Energy
3. Succeed
4. Achievement
5. Healthy
6. Good times
7. Cope
8. Liked
9. Friendships
10. Good news
11. Good decision
13. Praised
14. Hope
15. Problem solve

Unreleated Cue Words
1. Marriage
2. Family
3. Holiday
4. Career
5. Acknowledgement
6. Confident
7. Proud
8. Relaxed
9. Opportunities
10. Wealth
11. Celebration
12. Fulfillment
13. Independence
14. Stability
15. Develop

Table 1: Mean predictions (and standard deviations) as a function of time, valence of prediction event and intervention task.

		Simulation – Related Cues		Simulation – Unrelated Cues		Visualisation	
		Pre	Post	Pre	Post	Pre	Post
Likelihood	Positive	4.11 (0.78)	4.74 (0.72)	3.94 (0.55)	4.25 (0.72)	4.00 (0.92)	4.04 (0.86)
	Negative	3.13 (1.02)	2.32 (1.04)	2.72 (0.80)	2.27 (0.96)	2.90 (0.99)	2.77 (1.11)
Control	Positive	4.17 (0.76)	4.62 (0.59)	4.19 (0.84)	4.37 (0.72)	4.19 (0.84)	4.25 (0.92)
	Negative	2.87 (0.91)	3.16 (1.06)	3.17 (0.61)	2.95 (0.79)	3.09 (0.55)	3.07 (0.75)
Vividness	Positive	3.91 (0.79)	4.54 (0.91)	3.90 (0.67)	4.32 (0.77)	4.00 (0.85)	4.16 (0.78)
	Negative	3.18 (0.94)	2.44 (1.05)	3.08 (1.09)	2.78 (1.39)	3.19 (0.74)	3.19 (0.76)
Importance	Positive	4.68 (0.52)	4.95 (0.61)	4.65 (0.65)	3.10 (1.45)	4.54 (0.76)	4.61 (0.86)
	Negative	3.06 (1.27)	2.86 (1.39)	3.48 (1.41)	4.61 (0.86)	3.36 (0.90)	3.42 (1.31)

Table 2: Mean predictions (and standard deviations) as a function of time, valence of prediction event and depression status.

		Non-Depressed		Moderate Dysphoria		High Dysphoria	
		Pre	Post	Pre	Post	Pre	Post
Likelihood	Positive	4.38 (0.71)	4.66 (0.70)	3.97 (0.59)	4.33 (0.56)	3.01 (1.17)	3.82 (1.04)
	Negative	3.11 (1.09)	2.39 (1.15)	3.84 (0.82)	3.14 (0.84)	4.61 (0.88)	3.66 (1.22)
Control	Positive	4.35 (0.63)	4.53 (0.67)	3.97 (0.63)	4.19 (0.59)	3.28 (1.09)	3.80 (0.88)
	Negative	3.12 (0.91)	3.13 (1.09)	2.90 (0.79)	3.02 (0.86)	2.44 (0.98)	2.75 (0.93)
Vividness	Positive	4.37 (0.74)	4.66 (0.79)	3.95 (0.74)	4.25 (0.67)	3.51 (1.17)	4.10 (0.99)
	Negative	3.19 (0.83)	2.87 (1.05)	3.70 (0.95)	3.36 (1.10)	4.52 (0.89)	4.04 (1.27)
Importance	Positive	4.77 (0.47)	4.88 (0.52)	4.74 (0.58)	4.83 (0.98)	4.52 (0.77)	4.67 (0.97)
	Negative	3.30 (1.15)	3.23 (1.42)	3.32 (1.19)	3.09 (1.15)	3.64 (1.32)	3.45 (1.63)

Table 3: Mean predictions (and standard deviations) as a function of time and depression status for repeated simulations.

		Non-Depressed		Moderate Dysphoria		High Dysphoria	
		Pre	Post	Pre	Post	Pre	Post
Likelihood	0	4.46 (0.89)	4.61 (0.84)	3.92 (0.71)	4.20 (0.65)	3.10 (1.24)	3.52 (0.83)
	1	4.48 (0.77)	4.67 (0.77)	4.09 (0.76)	4.41 (0.63)	3.53 (1.10)	3.97 (1.02)
	5	4.44 (0.66)	4.59 (0.66)	3.99 (0.59)	4.28 (0.64)	3.07 (1.36)	3.72 (1.23)
Control	0	4.57 (0.77)	4.62 (0.79)	3.98 (0.81)	4.13 (0.74)	3.69 (1.26)	3.71 (1.03)
	1	4.24 (0.76)	4.37 (0.80)	3.97 (0.93)	4.23 (0.75)	3.44 (1.16)	3.77 (1.16)
	5	4.29 (0.76)	4.51(0.86)	4.00 (0.83)	5.27 (6.43)	3.20 (1.26)	3.52 (1.41)
Vividness	0	4.42 (0.84)	4.67 (0.89)	3.93 (0.96)	4.10 (0.87)	3.53 (0.87)	3.85 (0.95)
	1	4.42 (0.84)	4.63 (0.87)	4.03 (0.71)	4.45 (0.65)	4.06 (1.18)	4.35 (1.04)
	5	4.36 (0.84)	4.63 (0.83)	3.86 (0.91)	4.23 (0.78)	3.66 (1.26)	4.14 (1.18)
Importance	0	4.86 (0.61)	4.93 (0.68)	4.65 (0.79)	4.78 (0.66)	4.63 (0.76)	4.75 (0.83)
	1	4.79 (0.52)	4.85 (0.50)	4.75 (0.61)	4.89 (0.64)	4.68 (0.86)	4.82 (0.90)
	5	4.68 (0.73)	4.87 (0.75)	4.73 (0.64)	4.81 (0.50)	4.31 (0.73)	4.76 (0.91)

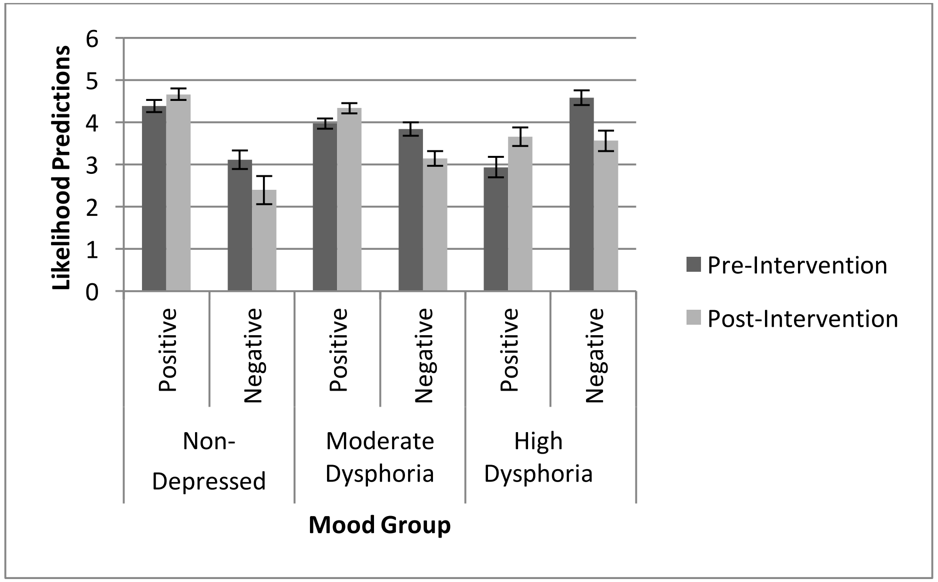

Figure 1: Changes in likelihood predictions pre-to post-intervention as a function of prediction event valence and depression status