



# Increasing Anticipatory Pleasure in Major Depression through Enhancing Episodic Future Thinking: a Randomized Single-Case Series Trial

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## Abstract

Individuals with depression have difficulty anticipating pleasure, which can negatively impact motivation and functioning. One factor in this may be impairments in their episodic future thinking (EFT). This study examined whether enhancing EFT through increasing detail/vividness and mental imagery would increase anticipatory pleasure among individuals with Major Depressive Disorder. A randomized start-point, single case series design was used. Depressed outpatients ( $N=7$ ) completed surveys throughout the day over 2 wks to nominate upcoming positive events and rate them on EFT detail/vividness, mental imagery, and anticipatory pleasure. At a randomized start-point, activities to enhance the detail/vividness and mental imagery for these upcoming events were introduced. Significant increases in detail and imagery were observed when EFT activities were introduced, which correlated with increases in how pleasurable it was thought the activities would be and how pleasurable it was thinking about them. Enhancing EFT may be a mechanism to increase anticipatory pleasure in depression. Implications for treatment are discussed.

**Keywords** Major depression · Anticipatory pleasure · Anhedonia · Episodic future thinking

Anhedonia refers to difficulty feeling pleasure as a response to experiences that might otherwise elicit a pleasurable, hedonic response, and is a core diagnostic feature of depressive disorders (American Psychiatric Association 2013; World Health Organization 1992). Some evidence-based psychological therapies, such as cognitive therapy (Beck 2011), behavioural activation (Hopko et al. 2003) and acceptance and commitment therapy (Hayes et al. 2011), put a particular emphasis on increasing rewarding and meaningful activities as a way of increasing hedonic responses and addressing anhedonia.

Recently, anhedonia has been increasingly conceptualised as a deficit in the ability to not only experience pleasure from behaviour that would usually be rewarding, but also as a deficit in *anticipating* the experience of pleasure (Gard et al. 2006; Gard et al. 2007; Treadway and Zald 2011). Indeed, evidence has accumulated that indicates large, significant deficits in self-reported levels of anticipatory pleasure (*removed for blinding*; Wu et al. 2017; Yang et al. 2014, 2017), and abnormalities in the neural correlates of reward anticipation amongst those who are clinically depressed (Stringaris et al. 2018). Deficits in anticipatory pleasure can be conceptualized as a maintaining factor in clinical depression, given it is a proximal influence in the motivation and intention to engage in rewarding and goal-directed behavior (Engel et al. 2013; Sherdell et al. 2012). Low anticipatory pleasure is predictive of low motivation for reward (Foussias and Remington 2008; Treadway and Zald 2011), low reward responsiveness (Foussias and Remington 2008), and generally poorer outcomes on psychosocial functioning in mental illness (Buck and Lysaker 2013; Foussias et al. 2011). Therefore, where one anticipates little pleasure from future experiences, intrinsic motivation for these experiences and intention to engage in them may also be low, positively-reinforcing behaviours are less likely to be engaged in, and this process may over time

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pervasively disrupt psychosocial functioning. Difficulty anticipating positive events in conjunction with a reduced experience of reward may then give rise to other factors that maintain dysfunction, such as generalized hopelessness about having positive experiences and outcomes for oneself in the future (MacLeod et al. 2005; O'Connor et al. 2000).

One possible reason for low anticipatory pleasure amongst depressed individuals may be the impairments they have in mentally simulating possible future events in specific and detailed ways. Activating and maintaining contextually detailed cognitive representations of experience are thought to be crucial for the anticipation of positive affect and reward (Kring and Caponigro 2010). However, studies have shown that when depressed individuals engage in episodic future thinking (EFT), that is, thinking of specific, spatially and temporally-located future events they might experience, compared to healthy controls they provide more general descriptions of categories of events or events that extend over long periods (*removed for blinding*). Further, when specific instances of future experiences are generated, they typically have less contextual detail (King et al. 2011). Kahneman (1982) theorized that individuals use a simulation heuristic when engaging in EFT, whereby mental representations that are more realistically represented in mind and easier to generate are perceived as more plausible and likely to occur. This might also then give rise to a stronger experience of anticipatory emotion. Accordingly, where depressed individuals lack the ability to cognize detailed representations of experiences that might be rewarding in their future, they may also be less likely to anticipate pleasure from the thought of that experience. Following from this, if the specificity and detail of EFT for positive events could be enhanced, then corresponding changes in anticipatory pleasure might also be expected.

Several studies to date have assessed the emotional effects of engaging in EFT for positive events in samples with depressive symptoms. Higher ratings of vividness for positive imagery have been shown to correlate with lower depressive symptoms in dysphoric individuals (Holmes et al. 2008), and imagining positive events using mental imagery shown to produce a stronger intensity of positive affect relative to verbal conditions (Holmes et al. 2008; Holmes et al. 2009). In a sample of dysphoric individuals, simulations of future events prompted by cues of abstract experiences (e.g., “people will admire you”, “you will be able to cope easily with pressure”) were shown to increase the self-reported vividness of the experiences, and the perceived likelihood that they would occur (Boland et al. 2018). As part of a trial of the effects of positive mental imagery on depressive symptoms, Renner et al. (2017) showed that higher vividness ratings of mental simulations of pre-scripted scenarios with positive outcomes were related to increased behavioural activation. Although not focused on depression, a pilot study of anticipatory skills training with five individuals with schizophrenia incorporated sensory

experiences of pleasurable events and examination of the possible rewards of behaviours in order to increase anticipatory pleasure (Favrod et al. 2010). The results showed change over time on a trait measure of anticipatory pleasure, although the possible mediating mechanism of increased detail in mental representations of positive events was not assessed. Recently, programs focused specifically on increasing positive affect in individuals with clinically-significant depression and anxiety symptoms have also been developed (e.g., Craske et al. 2019; Taylor et al. 2017a; Taylor et al. 2017b). These incorporate exercises in generating mental representations of positive future events and have been successful in producing large shifts in positive affect in these clinical samples.

A common feature of the studies discussed above is that they did not assess anticipatory pleasure. This is crucial in terms of assessing outcomes of simulating future experiences on the expectations of a hedonic response from these experiences, rather than using variables as a proxy for this that are only modestly correlated, such as positive affect (Gard et al. 2006), generalized optimism (Bryant 2003), and happiness (Bryant 2003; Saperia et al. 2018). As Renner et al. (2017) suggest, studies that assess and promote EFT for specific, personally-relevant events are needed to match the actual content and affective outcomes of the cognitions with desired behavioural outcomes. The ecological validity of examining EFT for events in daily life then, rather than abstractions or events that are not personally-relevant, seems important if effects are intended to be observed for experiences that actually occur in daily life. This approach may also increase the feasibility of translating such findings for use in established treatments that focus on increasing meaningful and rewarding behaviours. Renner et al. (2019) have recently shown that engaging in motivational imagery activities for planned behaviours can increase anticipatory pleasure in a non-clinical population (Renner et al. 2019), while *removed for blinding*, have shown that engaging in brief guided-EFT activities increase detail and imagery, which are then associated with higher levels of anticipatory pleasure. Nevertheless, it has not been tested whether or not such effects would also be found in those with depression.

## The Current Study

As outlined above, anticipatory pleasure deficits are linked with poorer motivation and psychosocial functioning, and represent a target for intervention in clinical depression. Given that depressed individuals have difficulties in effectively mentally-representing positive future events, one mechanism through which to increase anticipatory pleasure for upcoming events may be to enhance their EFT. The aim of this study was to examine whether providing EFT activities to depressed individuals would increase the level of contextual detail in

their mental simulations of upcoming positive events, and increase their anticipatory pleasure for these events. These activities were designed to encourage characteristics of EFT that are known to be related to increased affective response, such as using mental imagery (Pictet et al. 2011), using a first-person perspective (Holmes et al. 2008), and being temporally close (D'Argembeau and Van der Linden 2004). It was hypothesized that when engaging in enhanced EFT activities of upcoming positive events, relative to a control phase, depressed individuals would report higher levels of detail/vividness and mental imagery for these events, and higher levels of anticipatory pleasure. The current study was designed to focus on increasing the knowledge of mechanisms with which to improve treatments, and not on treatment per se. However, given the opportunity, we also measured relevant variables of mood, depressive symptoms, trait anticipatory pleasure, and behavioural activation. We predicted that if there were changes observed on these variables that they would be in the direction of improved mood, lower symptoms, and increased anticipatory pleasure and behavioural activation.

## Methods

### Design

The study used a replicated, randomized start-point single case series A-B design to test the effects of enhanced EFT on anticipatory pleasure across repeated measurements. The study was pre-registered prior to commencing recruitment and data collection (Australian New Zealand Clinical Trials Registry: 12618000257268). There were two phases in the study: Control (completion of measures) and enhanced EFT (EFT activities + completion of measures). Randomized start-point designs involve randomizing participants to one of a predetermined number of points where they switch from the control phase to the enhanced EFT phase. The number of possible points in which a participant can switch between phases is restricted so as to avoid having too few measurement points.

In this study, measures were taken five times per day (8:30 am, 11:30 am, 2 pm, 4:30 pm, and 7 pm) over the course of 14 days. The control phase lasted for a minimum of 15 data-points (3 d). There were then 25 subsequent data-points (the 16th data-point at the start of the fourth day to the 40th data-point at the end of the eighth day) that participants could be switched to the enhanced EFT phase. The enhanced EFT phase would then last for a minimum of 6 d or more dependent on the start-point participants were randomized to, until the last data-point (70th data-point at the end of the 2 wks). The primary outcome was anticipatory pleasure. The study was not designed as an intervention for depressive symptoms, however, we did include secondary outcomes of state mood

(assessed in the daily surveys), depressive symptoms, behavioural activation (both for the specific upcoming events, and in general), and trait anticipatory pleasure. The latter three were assessed at (1) baseline; (2) when participants switched between the control and enhanced EFT phases; and (3) at the end of the 2 wks. As a manipulation check, we assessed self-reported detail/vividness and use of mental imagery in relation to the upcoming events in both phases.

### Participants

The inclusion criteria were: aged between 18 and 65 years, a current Major Depressive Disorder (single or recurrent) as the primary complaint, and as diagnosed according to the International Classification of Diseases - 10th edition (World Health Organization), residing in Bengaluru, India, and fluency in the English language. Exclusion criteria were: psychotic depressive features, psychotic disorders, substance use disorder, neurodevelopmental or neurodegenerative disorders, obsessive-compulsive disorder, borderline personality disorder, and any concurrent psychosocial or psychological treatment. Antidepressant medication was not an exclusion criterion, but there was a requirement of being stable in type and dose for at least 4 wks prior to commencing the study. All participants taking antidepressant medication remained stable in type and dose throughout the study period.

A total of 10 participants were recruited for the study, but three were excluded prior to analyses. One participant advised at completion of the study that they had consistently violated the protocol by answering questions in the daily surveys at random and one participant completed only 22.5% of data-points. The remaining participant showed depressive symptoms in the normal range at baseline (i.e., a score of 4/21 on the depression subscale of the Depression, Anxiety, Stress Scale; Lovibond and Lovibond 1995), and we hypothesize that they may have had a spontaneous remission in the period between referral and baseline assessment. Given that the study was designed based on examining changes in EFT in those with clinical depression, this participant was deemed unsuitable for inclusion\*. The remaining participants all scored  $\geq 10/21$ , indicating clinically-significant symptoms concordant with their diagnosis. The characteristics of the sample used in analyses are shown in Table 1. As indicated, the sample was wholly male, with Major Depressive Disorder of mostly mild to moderate severity for at least 3 mo duration (median of 10 months). Most had previous episodes and were on medication, and only two had co-morbid mental illness.

\*Note: In the context of other cases, this participant in the normal range of depressive symptoms had high mean scores in the control phase. Further, they reported almost no mean change on detail/vividness and the anticipatory pleasure variables, despite good compliance. Although detail and anticipatory pleasure can be increased in non-clinical samples

**Table 1** Participant Characteristics

ID	Age	Gender	Educational Attainment	Relationship Status	Severity of MDD	Duration of MDD Episode (months)	Previous MDD Episodes	Co-morbidities	Medications (all daily doses)
P1	18	Male	High-school	Single	Severe	13	1	/	Sertraline 100 mg
P2	24	Male	Bachelor Degree	Single	Moderate	18	2	/	Fluoxetine 20 mg
P3	19	Male	High-school	Single	Mild	3	1	Panic Disorder	/
P4	31	Male	Bachelor Degree	Non-married relationship	Moderate	10	1	/	Sertraline 100 mg
P5	22	Male	Bachelor Degree	Single	Mild	3	2	/	Escitalopram 10 mg
P6	28	Male	Bachelor Degree	Single	Mild	4	0	/	/
P7	26	Male	High-school	Single	Moderate	48	2	Social Phobia	Fluoxetine 60 mg

MDD = Major Depressive Disorder, mg = milligrams

(removed for blinding), it was not so in the case of this participant.

## Materials

The daily surveys were sent to the participants' phone via email, in which a link to the survey was provided, and EFT activities in the second phase. In each of the daily surveys, participants were asked to choose an activity that they were most looking forward to or could possibly do over the next 2 hrs that they would find enjoyable or would give them a sense of achievement. Participants were told that if they nominated something they were a) currently engaged in, and b) would be continuing to do until the next data-point, then they should try to think about a particular aspect of that experience that was still upcoming and that might be positive in terms of enjoyment or achievement. An example of this was if the participants were at work or school then they might think about what it would be like when they finished a smaller task during that activity, or they took a break to relax. They then selected from a number of pre-set categories of events consistent with Wu et al. (2017): *work/school/study, TV/internet/games/media, conversation/socializing, errand/chores, a hobby (not physical activity), physical activity/exercise, eating/drinking, or other activity not listed above* (and asked to specify what the activity was within this category). Some examples of each activity were provided to prompt responses. For example, for the *hobby* category the following were listed: reading a book or magazine, doing a puzzle, playing an instrument, or listening to music.

To assess the variables of interest in the daily surveys, a series of single-item measures were used; a common approach in studies that repeatedly assess episodic thinking throughout the day (Barsics et al. 2016; Beaty et al. 2018). This was also

in consideration of the large number of surveys, to reduce burden and increase response rate. All responses were made using a 0–100 scale with a sliding bar. Mood was assessed at the start of each daily survey with the items, “Please rate how sad you are right now”, (0 = not sad at all, 100 = extremely sad) and “Please rate how happy you are right now” (0 = not at all happy, 100 = extremely happy).

The mental detail/vividness of the upcoming activity was assessed using the item “How vivid and detailed was your thought of the activity?”, and mental imagery was assessed with the item, “How much did you find yourself thinking in pictures/mental images about the activity?” (both 0 = not at all, 100 = very much so). Participants were then asked to indicate whether they completed the activity that was chosen in the previous survey (Yes/No).

State anticipatory pleasure was then assessed using two items; one referring to how enjoyable the upcoming event would be, “How pleasant/enjoyable do you think it will be to do this activity?”, and the other referring to how enjoyable it was to think about doing the activity, “How pleasurable/enjoyable is it to just think about doing this activity?”, (both 0 = not at all, 100 = very much so).

**Depression, Anxiety, and Stress Scale (DASS; Lovibond and Lovibond 1995)** The 7-item self-report depression subscale from the DASS 21-item short-form was used to assess for depressive symptoms. The short-form of the DASS depression subscale assesses the core features of depression (e.g., *low mood, loss of interest, self-worth, and motivation*) and has good psychometric properties (Antony et al. 1998). The items were summed, with higher scores indicating a higher severity of depressive symptoms. Internal reliability was found to be acceptable in the current study (Cronbach's  $\alpha$  across time-points = .82).

**Temporal Experience of Pleasure Scale (TEPS; Gard et al. 2006)** The 10-item anticipatory pleasure subscale of the self-report TEPS was used to assess for trait levels of anticipatory pleasure. The TEPS uses a combination of concrete (e.g., “When ordering something off the menu, I imagine how good it will taste”) and abstract items (e.g., “When something exciting is coming up in my life, I really look forward to it”) to assess the general ability to experience anticipatory pleasure. Responses were given on a 6-point scale (1 = *Very false for me*, 6 = *Very true for me*), and items were summed so that higher scores indicated a stronger tendency to anticipate pleasure. Internal reliability was found to be acceptable in the current sample (Cronbach’s  $\alpha$  across time-points = .71).

**Behavioral Activation for Depression Scale (BADSD; Kanter et al. 2006)** The BADSD is a 25-item, self-report measure of behavioral activation. The 25 items assess goal-directed activity and completion of scheduled activities, avoidance of aversive states and rumination, and impairment in work/school and social domains. The items were summed, with higher scores indicating less avoidance and more behavioral engagement. Internal reliability was found to be acceptable (Cronbach’s  $\alpha$  across time-points = .81).

Although there were initial plans to administer the Episodic Future Thinking-Test (*blinded for review*) this was abandoned due to time restrictions for assessment with the first two participants, and it was subsequently deemed too burdensome.

**Enhanced Episodic Future Thinking Activities** The EFT activities were designed to increase the detail and mental imagery with which participants thought of upcoming events, and evoke a related emotional response. To do this, participants were asked to use a first-person perspective when thinking about the activity, and provide written accounts of thoughts, feelings, contextual details, and sequences of actions that would occur in the forthcoming activity. They were first given the instructions: “Now we would like you to think very intensely about this enjoyable activity that you chose. Think strongly about it and what it would be like to do. Imagine it happening from your own eyes/perspective. Really think strongly about this possible positive activity and use pictures in your mind, like a movie. Imagine what it would feel like to do this activity”. They then provided answers to six open-ended questions designed to help them generate episodic detail about the possible event: “Where will you be?”, “Describe what you will see from your own eyes”, “Describe what will happen during this positive experience?”, “Describe some positive things that you might think”, “Describe the positive feelings that you will have during this activity”, and “What will be the best part of it?” They were then asked to choose which positive emotions they might feel during this activity from a list of adjectives from the positive affect subscale on the Positive and Negative Affect Schedule (Watson et al. 1988); “happy,

excited, strong, enthusiastic, proud, inspired, determined, attentive, interested, and hopeful”, with the words “calm” and “amused” added to increase the range of responses.

## Procedure

Prior to commencing the study, ethics approval was obtained from the university research human ethics committee and the *blinded for review* ethics committee. Potential participants were identified through the intake procedures of the adult outpatient department of *blinded for review*. Individuals who fit criteria for participation were identified by clinicians (psychiatrists, clinical psychologists, and psychiatric social workers) and permission was asked to be followed up by the research team. The diagnosis and severity of Major Depressive Disorder and other eligibility criteria were confirmed with the referring clinician prior to this follow-up. The participant was then contacted via phone or in person at their next scheduled appointment at the outpatient department. They were provided with a plain language consent form, and provided signed consent. Participants then completed baseline measures using a laptop computer, and were guided through how to complete the daily surveys of the control phase by a researcher. They were then randomized to a start-point for the enhanced EFT phase using an online randomizer ([www.randomizer.org](http://www.randomizer.org)), and the daily surveys commenced the following morning at 8:30 am. They attended the outpatient department again at the time and date of the enhanced EFT phase start-point to complete another set of measures, and were guided through how to complete the EFT activities that would be added to the daily surveys. At the end of the 2 wks they again met with a researcher to complete the final set of measures and to debrief on their experience. The researchers contacted each participant shortly after the commencement of each phase, to encourage completion of the daily surveys. The participants were reimbursed with 500 Indian Rupees upon each visit to the outpatient department.

## Data Analysis

Descriptive statistics, a MANOVA to assess differences between categories of events, and multiple regressions to assess the association of detail/vividness and mental imagery with anticipatory pleasure were conducted using SPSS 24.0. To assess primary and secondary outcomes, Baseline Corrected Tau (BCT) was used to assess whether change took place from the control to enhanced EFT phase for each participant (Tarlow 2017). BCT provides a non-parametric inferential test for differences in scores between phases. It is appropriate for single-case designs as it does not necessitate normal distribution of data, has good statistical power, and is robust to outliers. BCT analyses can also correct for trends in the control phase by first detecting whether a trend is occurring then

statistically removing this trend so it equals or approaches zero before data is analyzed. This is particularly relevant where it is possible that an initial control phase might itself produce changes in scores on some variable. It is noted then that BCT analyses may produce effects that are in the opposite direction to mean changes between phases where significant trends in an initial phase are found. The BCT procedure provides an effect size estimate that is based on rank correlations and therefore is less biased by outliers than the standardized mean difference. Suggested interpretations for effect sizes of the related Tau-U statistic are as follows: below .20 a small effect, .20–.60 moderate, .60–.80 large, and above .80 very large (Vannest and Ninci 2015). It is also noted that the Tau-U statistic is not always bounded between  $-1$  and  $+1$ , whereas the BCT used here is. Therefore, these effect size interpretations may underestimate the effect size of BCT statistics. In order to estimate an overall effect across participants on the outcome measures, the effect sizes and  $p$  values from BCT were combined using meta-analysis with Edgington's additive method (Edgington and Onghena 2007) using WINPEPI software (Abramson 2011).

Inferential tests are not reported for depressive symptoms, trait anticipatory pleasure, and behavioural activation given the small sample and inadequate power to detect changes, however, standardized mean differences are reported as a description of mean change and direction. Spearman rank correlation coefficients were used to assess their bivariate associations.

An average of 32.2% of data was missing for each of the participants (range 20.75–45.65%), which was unsurprising given the large number of data-points and repetitive nature of the daily activities. The non-significant results of Little's MCAR test on data from each participant indicated it was unlikely there were patterns in the missing data (all  $p < .05$ ). This missing data was replaced using expectation maximization; a single imputation technique which has been shown to preserve inferential integrity in single case designs that are missing significant amounts of data (Smith et al. 2012). Given that autocorrelation is known to affect the power of the replacement procedure, we assessed this by correlating data-points with lag-1 correlations (the next data-point). Across variables and participants, the average autocorrelation was  $r = 0.33$  (range 0.09–0.75), indicating this replacement method was acceptably powered (Smith et al. 2012).

## Results

The frequency of endorsement of the upcoming activity categories, in descending order, were: work/school/study (23.6%), TV/internet/games/media (21.6%), other activity not listed above (18.4%), conversation/socializing (12.1%), eating/drinking (11%), errand/chores (7.9%), hobby (not physical

activity; 2.7%), physical activity/exercise (2.7%). To assess whether there were differences on the anticipatory pleasure items between the different activity categories, a MANOVA was conducted, using phase as a covariate to control for score differences between control and enhanced EFT phases. The results indicated a significant multivariate effect for activity category,  $F(14, 708) = 3.53$ ,  $p < .001$ , and univariate effects for how enjoyable participants thought the upcoming activity would be,  $F(7, 345) = 5.72$ ,  $p < .001$ , and how enjoyable it was to just think about,  $F(7, 345) = 5.26$ ,  $p < .001$ . Post-hoc tests were conducted to assess differences between the categories, using Games-Howell corrections in the context of unequal sample variances and sizes. The results showed differences in categories were consistent for the two anticipatory pleasure items with TV/internet/games/media and conversation/socializing evoking significantly more anticipatory pleasure than work/school/study, eating/drinking, and "other activity not listed" (all  $p < .05$ ). No other differences were found.

Regarding the six prompts for episodic detail for the future events, the participants provided at least some written response to 98.6% of the daily surveys that were attempted. In total, responses were provided to 95.2% of all the episodic detail prompts in daily surveys that were attempted. This indicates that the fidelity of Phase B EFT activities was excellent, and when participants completed a daily survey they almost always provided a variety of episodic detail.

## Mechanisms of Change/Manipulation Check

The results from the BCT analyses indicated significant increases in detail/vividness from control phase to enhanced EFT phases for five participants, with one showing no significant change (P6) and one showing a significant decrease after baseline trend correction (P1). The meta-analysis, with combined  $p$  values, indicated an overall statistically significant increase in detail/vividness (BCT = .271,  $p = .046$ ). For mental imagery, the results indicated significant increases in mental imagery for five participants, with the remaining showing no significant change (P6 and P7). The meta-analysis with combined  $p$ -values indicated an overall statistically significant increase in mental imagery (BCT = .336,  $p = .001$ ). In summary, the majority of participants increased in detail and mental imagery, and meta-analyses showed evidence for overall effects. Using the trend analysis component of BCT, we analysed detail/vividness and mental imagery to examine whether there was a trend in change within the enhanced EFT phase\*. The results were inconsistent across participants, with two participants showing significant increases in detail/vividness and mental imagery over the enhanced EFT phase, one showing a significant decrease, and the remaining participants showing no significant change (full results in Supplementary Table 1).

The association between detail/vividness and mental imagery and anticipatory pleasure was then assessed. Using the data prior to missing values replacement, strong, positive correlations between higher detail/vividness and higher anticipatory pleasure were observed for expected pleasure,  $r(355) = .68, p < .001$ , and pleasure thinking about the events,  $r(361) = .80, p < .001$ , and for mental imagery and expected pleasure,  $r(361) = .68, p < .001$ , and pleasure thinking about the events,  $r(360) = .80, p < .001$ . Detail/vividness also correlated highly with the use of mental imagery,  $r(354) = .88, p < .001$ . All correlations remained the same after controlling for phase. Therefore, detail/vividness and mental imagery were associated with stronger anticipatory pleasure.

\*Note: As requested by a reviewer of the manuscript.

Multiple regressions were then conducted to explore whether detailed/vividness and mental imagery independently predicted the anticipatory pleasure variables, while controlling for phase.

The model for expected pleasure for the event was significant,  $F(2, 350) = 184.5, p < .001$ ,

indicating the variables predicted 54% of variance in expected pleasure. Phase was a significant predictor ( $\beta = .20, p < .001$ ), and both detail/vividness ( $\beta = .32, p < .001$ ) and mental imagery ( $\beta = .39, p < .001$ ) explained independent variance. The model for pleasure thinking about the upcoming event was also significant,  $F(2, 350) = 386.5, p < .001$ , and indicated the variables predicted 69% of variance in pleasure from thinking about the upcoming event. Again, phase was a significant predictor ( $\beta = .06, p = .023$ ), and detail/vividness ( $\beta = .40, p < .001$ ) and mental imagery ( $\beta = .44, p < .001$ ) both explained unique variance. This indicated that higher detail/vividness and mental imagery independently predicted stronger anticipatory pleasure.

### Primary Outcome: Anticipatory Pleasure

Table 2 shows the descriptive statistics for the primary outcomes, and Figs. 1 and 2 show graphical representations of scores over time. As indicated, all participants showed increases in their mean scores on how enjoyable they thought it would be to do the upcoming events. The BCT analyses showed three participants had significant increases between the phases, with the remaining showing no significant change. The meta-analysis with combined  $p$ -values indicated an overall statistically significant increase in how enjoyable the participants thought it would be to experience the upcoming event (BCT = .243,  $p < .001$ ). For how enjoyable it was to think about the upcoming events, the results indicated significant increases for all participants. As expected, the meta-analysis with combined  $p$ -values indicated an overall statistically significant increase on how enjoyable it was to think about the upcoming events (BCT = .298,  $p < .001$ ). In summary, the participants reported increases in anticipatory pleasure,

although this was more consistent for how enjoyable it was to think about experiencing the upcoming event relative to how enjoyable they thought it would be to actually do.

### Secondary Outcomes

Turning to analyses of the frequency of engaging in the nominated behaviours, it is noted that P3 was excluded as all of their responses were “yes” and therefore there was no variance to estimate missing data with (see Supplementary Table 2 for all participants statistics). The results showed significant decreases in frequency of engaging in the nominated behaviours for two participants (P6 and P7), and no other significant changes amongst the participants. The meta-analysis combining effect sizes and  $p$ -values indicated that, overall, participants did not collectively change between the phases (BCT = .027,  $p = .555$ ).

There was inconsistency across participants regarding mean changes in sadness and happiness between the phases. The results for sadness indicated significant decreases for four participants, and a significant increase for one (P5). The meta-analysis indicated a statistically significant decrease in sadness (sadness: BCT =  $-.108, p < .001$ ). For happiness, there were significant decreases for two participants (P5 and P7) and no other significant changes. The meta-analysis indicated no overall statistically significant change in happiness (sadness: BCT = .100,  $p = 1.00$ ).

Changes in mean scores (see Table 3) were not apparent from baseline to the end of the enhanced EFT phase for the measures of depressive symptoms ( $d = .07$ ) and trait temporal experience of pleasure ( $d = -.15$ ), but some mean change was observed for behavioural activation ( $d = .42$ ). To examine the associations between these three measures, Spearman rank correlations were conducted. The average correlation across time-points between the DASS and TEPS-A was  $r = -.44$ , the average correlation between DASS and BADS was  $r = -.58$ , and the average correlation between TEPS-A and BAD was  $r = .56$ .

### Discussion

This study aimed to investigate whether enhancing EFT for upcoming positive events in daily life would increase the anticipatory pleasure related to these events in individuals with Major Depressive Disorder. Taken collectively, the results showed that the majority of participants' self-reported detail/vividness and use of mental imagery for upcoming events increased when the EFT activities were introduced. Further, during the enhanced EFT phase these changes were generally maintained, with two participants showing a trend for continued improvement during this training phase, and only one showing a trend for decline (but, nonetheless, still improving

**Table 2** Descriptive Statistics, Effects Sizes and P-values for Anticipatory Pleasure Variables

Participant	Control Mean	Enhanced EFT Mean	Control Phase SD	Baseline Trend Tau	BCT	BCT SE	BCT <i>p</i> -value
<i>How enjoyable the upcoming activity was perceived as being</i>							
P1	26.65	32.33	14.04	.038	.285	0.156	.004
P2	22.50	46.30	13.76	.363**	.043	0.169	.667
P3	49.31	69.46	13.06	-.188	.502	0.146	<.001
P4	54.14	69.92	6.89	.362*	.027	0.169	.792
P5	41.90	64.07	23.34	.050	.516	0.145	<.001
P6	14.30	16.59	9.60	-.125	.162	0.167	.119
P7	45.00	53.78	17.60	.000	.171	0.165	.096
<i>How enjoyable it was thinking about the upcoming activity</i>							
P1	38.35	53.74	9.2	.167	.560	0.140	<.001
P2	42.68	56.16	6.35	.331*	.204	0.167	.041
P3	44.17	57.34	9.82	-.005	.499	0.146	<.001
P4	36.74	54.94	7.86	.266	.661	0.127	<.001
P5	56.32	46.27	10.66	-.373**	.395	0.155	<.001
P6	48.51	50.83	10.43	.348*	-.520	0.144	<.001
P7	45.62	51.51	10.82	-.013	.294	0.158	.003

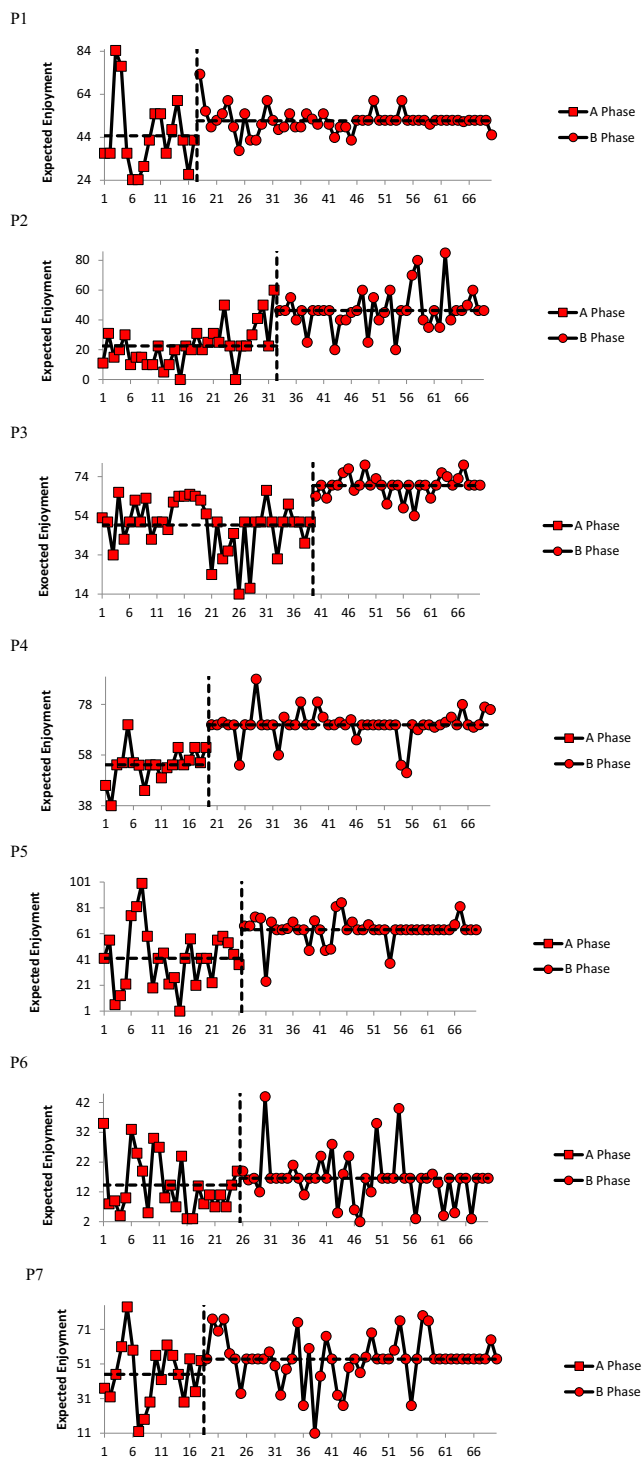
\*Significant baseline trend at the  $p < .05$  level, which was corrected for. BCT = Baseline Controlled Tau

from control to enhanced EFT phases). The high level of compliance with the episodic detail prompts in the EFT activities lends a high degree of confidence of this. The participants also reported anticipating more pleasure when thinking about upcoming events, relative to the control phase. Further, the reports of detail/vividness and mental imagery were strongly and independently associated with higher scores on both anticipatory pleasure items. This suggests that enhancing EFT was a mechanism for increasing anticipatory pleasure, and that detail/vividness and mental imagery were distinct characteristics of EFT that, when increased in conjunction, promoted higher expectation and experience of pleasure in this sample.

Depressed individuals demonstrate significantly less specificity and detail when simulating future events (*removed for blinding*). Contextual detail/vividness in the simulation of future events is important in determining how plausible and realistic these events are judged to be (Boland et al. 2018; Kahneman 1982), and mental imagery (Holmes et al. 2008, 2009; Holmes et al. 2006) can help boost the positive feelings that they evoke. Therefore, a paucity of detail, low salience of incentives, and less evoked positive emotion (Whitton et al. 2015) may explain why depressed individuals also report less anticipation of pleasure for upcoming events (Wu et al. 2017), and decreased responsiveness to the notion of reward (Henriques and Davidson 2000; McFarland and Klein 2009). This study provides evidence that anticipatory pleasure can be increased among depressed individuals by enhancing the detail/vividness and mental imagery that they use to imagine future events.

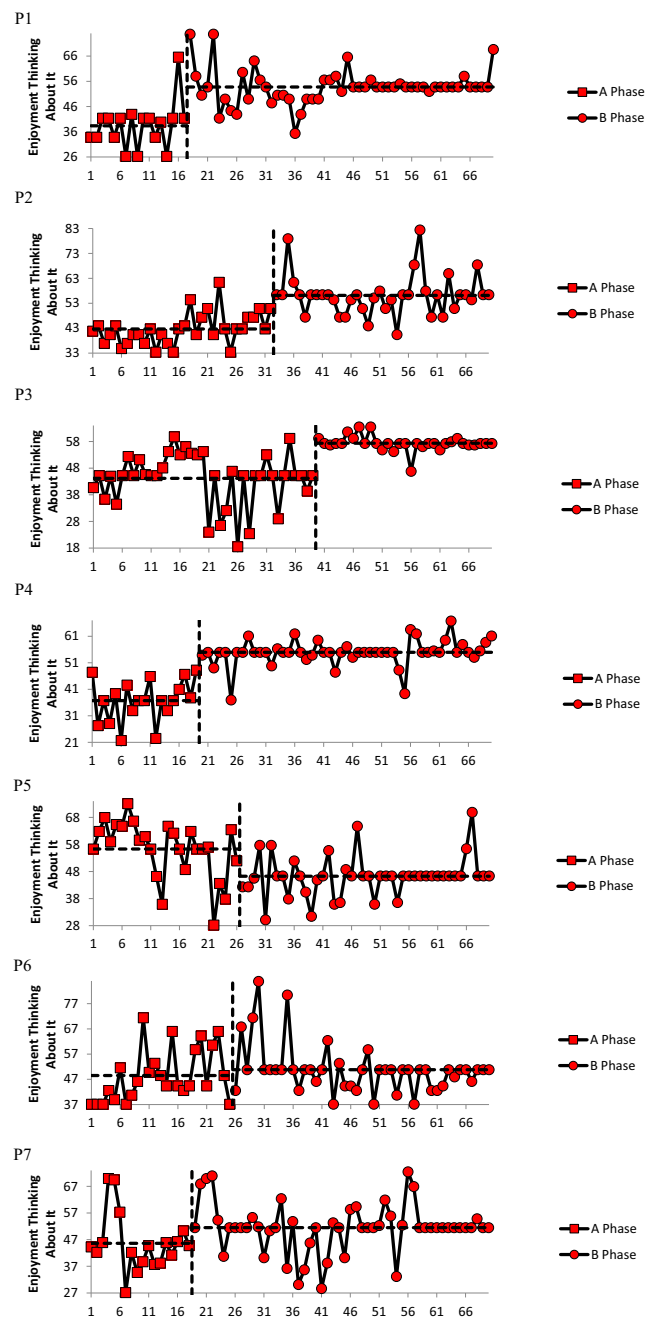
As noted, mean changes in responses were seen in the hypothesised direction on the EFT and anticipatory pleasure variables for the majority of participants. One participant, however, reported a decrease in enjoyment when thinking about the events (P6). It is unclear why this happened, although it is notable that this same participant did not increase on detail and mental imagery, instead reporting decreases (albeit not statistically significant). Therefore, these changes are at least consistent with the overall associations between detail, mental imagery, and anticipatory pleasure variables, and the theory that anticipatory pleasure will increase as a product of changes in these EFT variables. It is possible that this individual found it difficult to engage in the upcoming events to enhance their EFT, which may have led to feeling demoralised about upcoming positive events over time, although this is, of course, speculative. It was notable that the participant did not show reductions in the expectation of enjoyment though. Findings among previous studies have been inconsistent in regard to the strength of association between expecting enjoyment and experiencing enjoyment in thinking about a future event, with some showing strong correlations (Barsics et al. 2016), and others weak (Baumgartner et al. 2008). The variables strongly correlated in this study, and both changed across the sample to a similar degree. Therefore, it is reasonable to believe that, overall, participants experienced pleasure at the time of thinking about events that they perceived would be more pleasurable, or at least that these constructs significantly overlapped in how participants conceptualized them.





**Fig. 1** Measurements of anticipatory pleasure (“How pleasant/enjoyable do you think it will be to do this activity?”) across the control and enhanced EFT phase, with anticipatory pleasure ratings on the Y-Axis and data-point over the 2 wks on the X-Axis

No changes were observed on the trait measure of anticipatory pleasure, although this was not a primary outcome and, given the brevity of the study, unlikely to be affected. Strong correlations were found between anticipatory pleasure,



**Fig. 2** Measurements of anticipatory pleasure (“How pleasurable/enjoyable is it to just think about doing this activity?”) across the control and enhanced EFT phase, with anticipatory pleasure ratings on the Y-Axis and data-point over the 2 wks on the X-Axis

behavioural activation, and depressive symptoms, supporting previous findings of associations between anticipating pleasure and behavioural functioning in clinical samples (Buck and Lysaker 2013; Foussias et al. 2011). It would be useful to include these measures in future studies of depression treatments to track if changes are associated with one another over time. To our knowledge, only one study has assessed trait anticipatory pleasures as an outcome of an intervention, reporting evidence for increases in a small group of

**Table 3** Descriptive Statistics for Study Variables

	DASS-D	TEPS-A	BADS
Baseline	14.1 (3.2)	37.1 (10.4)	39.5 (15.9)
Between Phases	14.2 (5.5)	36.8 (9.4)	51.8 (11.1)
Post Enhanced EFT Phase	14.4 (4.5)	35.7 (8.4)	45.8 (13.3)

DASS-D = Depression subscale of the DASS-21, TEPS-A = anticipatory pleasure subscale of the Temporal Experience of Pleasure Scale, BADS = Behavioural Activation Scale for Depression

schizophrenia patients after a course of structured psychological treatment (Favrod et al. 2010).

The current study was designed to test a plausible mechanism to increase anticipatory pleasure in a clinically-depressed sample. Unsurprisingly then, simply asking depressed individuals to repeatedly engage in EFT activities for positive events that could occur in their daily life did not significantly impact depressive symptoms. No overall significant change was observed on engagement in the behaviours that were nominated in the EFT activities either. We note that on debriefing from the study, almost all participants reported that although they had not always engaged in the nominated behaviour (e.g., because of practical reasons, plans changing due to circumstances, changing their mind) they felt that it encouraged them to engage in other behaviours/events they might not have otherwise. The evidence for an increase on the behavioural activation measure is consistent with this, although this was not a primary outcome of the study and these findings are considered to be preliminary in nature.

There are a number of considerations in regard to the methodology used in this study. Firstly, participants commented that the data-points were too frequent across the day, which made it difficult for them to continue to generate a great variety of activities that they would enjoy. This suggests there are boundary conditions in terms of the level of creativity and diversity in positive activities that individuals will choose in daily life. Reducing the number of data-points in future studies would help rectify this to some degree. Alternatively, the timing of the daily surveys could be random through the day to introduce more variability in terms of when participants are asked. This might help capture differences in when participants engage in different activities. This might also help reduce habituation in responses that might have occurred (e.g., working at the same time each day and habitually answering the same way). All participants indicated that at times they tended to nominate events that they were already engaged in, especially if they lasted over several data-points. Although focusing on aspects of tasks they were already engaged in was inconsistent with the protocol, this involves reappraisal of a current activity rather than generation of a separate, novel experience. It would be interesting to investigate whether the effects of

enhanced EFT activities are different dependent on whether the nominated events are already underway. Different types of EFT activities might be needed to guide individuals to modify their current expectations of their short-term future. It also raises the issue of temporal distance. In this study we focused on daily experiences, but it would be interesting to examine whether EFT activities for more distal events or goals would also have effects on anticipatory pleasure, and goal-directed behaviour. Another possible limitation is demand characteristics. Although this limitation is inherent in research with explicit aims and self-report methods, the participants were asked to answer as honestly as they could when completing the surveys. Further, the excellent compliance in written prompts for episodic detail in the EFT activities provided evidence they were actually generating this detail and not just providing higher responses on the self-report scale. Relatedly, the mean scores for detail and mental imagery, although higher when the EFT activities were introduced, did not reach the highest quartile, with most in the second or third quartile. This suggests that there is capacity to further improve the generation of detail and use of mental imagery, perhaps through more, or more specific, prompts, or incorporating guided mental imagery (e.g., Blackwell et al., 2015; Holmes et al. 2009).

Although expectations of pleasure are related to decision-making about engaging in behaviours (Mellers et al. 1999), so are other factors that were not assessed in the current study. Perceived control over future events may be a key factor, as an individual's view of how capable they are in enacting a behaviour or experiencing an event is related to their attitudes towards it, and their intention (Armitage and Conner 2001). Anticipated enjoyment from an event may also be partially contingent on the importance that it has in the context of someone's personal goals or values. Assessing the personal significance of upcoming events would help establish if this moderates any effects. Measuring the strength of different types of feelings that people anticipate they might experience would also be useful. This might be particularly useful in differentiating between behaviours that produce pleasure due to their hedonistic nature (e.g., eating something delicious, enjoying conversation with another), or positive emotion in the form of pride or achievement, which might be more closely related to self-efficacy (e.g., finishing a set task at work, completing a chore at home). Some instrumental, goal-directed behaviours provide positive emotional reward when their end-point is reached, rather than through the process of reaching an end-point. The category of work/school/study was one of the most frequently chosen, and some of these events might generally be perceived as producing a sense of achievement rather than being a purely hedonistic pursuit, such as consuming entertainment. Indeed, this pleasure/achievement distinction might account in part for the substantial within-subject variation of reported anticipatory pleasure for

particular future events (i.e., TV/internet/games/media and conversation/socializing evoked significantly more anticipatory pleasure than work/school/study and eating/drinking). Given that engaging in EFT activities appears to be related to self-efficacy, and perceived ability to cope (Brown et al. 2002), this indicates the need for ordinal measurement of anticipated feelings of achievement, pride, accomplished, or the like. Activities geared towards instrumental tasks may benefit from a more nuanced approach to EFT than presented here for breaking down the steps in achieving an end-point.

A further consideration is whether activating mental representations of past positive events in conjunction with generating future events might further enhance anticipatory pleasure. Reactivating mental representations of experiences that are similar in nature to those that are, or could be, upcoming might help prime episodic thinking to incorporate these details, increasing the plausibility of an event, and the anticipation of it as being enjoyable. Indeed, engaging in episodic thinking for past events does have effects on detail in EFT (*removed for blinding*; Madore and Schacter 2014; Madore and Schacter 2016), and in one clinical study with schizophrenia patients, the prediction of pleasure from future events was comparable to healthy controls only when first recalling and describing memories (Painter and Kring 2016). This priming of similar past experiences may therefore be another mechanism through which to enhance EFT and increase anticipatory pleasure.

These findings may have implications for intervention. Behavioural activation treatments currently have good evidence for reducing depressive symptoms (Ekers et al. 2014), and could be potentially enhanced by the addition of EFT activities to promote rich mental representations of positive events that evoke anticipatory pleasure prior to engaging in them. The mobile phone-based approach used in this study was feasible to implement, and may be useful to promote motivation and, ultimately, positively-reinforcing behaviours. In contrast to the current study, this might be particularly effective where the events are pre-planned and factors such as the possible barriers to engaging in it, and the personal significance, have been methodically discussed by the therapist and patient. Interventions using positive mental imagery have already been utilized in the form of cognitive-bias modification to treat depressive symptoms and reduce anhedonia (Blackwell et al., 2015). Such interventions could also be brought to bear on the daily events in depressed people's lives as a way of increasing their anticipated pleasure for proximal events. In the current study, future events were simulated only once each. Repeatedly simulating specific experiences that could occur in the future has been shown to increase their emotional valence and plausibility (Szpunar and Schacter 2013), but conflicting results have been found for dysphoric individuals (Boland et al. 2018). If repeated EFT is tested as a

method of further enhancing anticipated pleasure, it may require fewer events to be nominated to avoid burnout or fatigue in relation to thinking about the experiences.

Another possibility is the development of programs to increase generalized specificity and detail in EFT. Memory specificity training, whereby depressed individuals are taught to recall specific and detailed memories to redress deficits in this ability, has been shown over a series of clinical trials to be effective in reducing depressive symptoms (Eigenhuis et al. 2017; Neshat-Doost et al. 2013; Werner-Seidler et al. 2018). Recent research using Future Specificity Training (FesT) has also shown some success in establishing that future thinking can be trained (Hallford et al. (2020). Training in specificity and detail in thinking about future events might also be beneficial in helping depressed individuals develop a generalized tendency to simulate positive events using characteristics discussed here that increase the anticipated pleasure. Including physiological measurements of changes in the reward systems of the brain may be another method of assessing the impact of training for EFT. For example, the use of electroencephalography to assess for changes in event-related potentials in areas associated with reward expectation and responsiveness, such as in the parietal lobes, (P2 and P3 areas; Flores et al. 2015; Novak and Foti 2015), and increases in asymmetry in frontal lobe activity, favoring the left frontal lobe, which would indicate higher approach motivation (Nelson et al. 2018; Pizzagalli et al. 2005).

In conclusion, the current study provides some support for the theory that the anticipation and experience of pleasure for upcoming positive events can be increased in those with clinical depression increasing the detail/vividness and use of mental imagery when using EFT to simulate these events.

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## Compliance with Ethical Standards

**Conflict of Interest** Author D. J. Hallford, M. K. Sharma and D. W. Austin declare they have no conflict of interest.

**Experiment Participants** None

**Ethics Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee of blinded for review and the blinded for review, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

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