INVESTIGATING THE EFFECT OF MENTAL IMAGERY BASED FUTURE EPISODIC SIMULATION ON SUBSEQUENT BEHAVIOURAL ENGAGEMENT IN DEPRESSED, DYSPHORIC, AND NON-DEPRESSED INDIVIDUALS

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Abstract

Previous work has suggested that mental imagery may represent a useful strategy for motivating goal-directed behaviours. Given that individuals experiencing depression symptoms have low motivation to engage in pleasurable activities, this study aimed to explore the effect of mental imagery on activity engagement for pleasurable activities in non-depressed, dysphoric, and depressed individuals (N = 163). Participants selected four activities they wished to engage in and rated expected outcomes and anticipated emotions relating to activity completion before and after mental elaboration of each activity using either mental imagery or verbal reasoning. Over the following week, utilising ecological momentary assessment (EMA), participants recorded the frequency with which they engaged in their chosen activities. Results showed both conditions led to similar levels of behavioural engagement, across all participants, suggesting that both tasks may influence behavioural engagement. Research is now needed to investigate the underlying mechanism/s by which behavioural engagement is occurring.

Keywords: Behavioural Engagement, Depression, Prospective Cognition, Mental Imagery, Ecological Momentary Assessment

General Audience Summary

Depression often leads to negative thinking and loss of interest and motivation to do activities that feel good or make us feel accomplished. Recent research suggests that mental imagery —visualising vivid experiences in the mind without external input — might help improve future outlook and motivation to do feel-good activities. However, previous studies have shown mixed results, indicating the need for further investigation.

In this study, researchers wanted to test whether using mental imagery to mentally rehearse doing the activities and pre-experiencing the positive outcomes would motivate people who differed in their level of depressed mood to do these activities. The study involved 163 participants who chose four pleasurable activities they wanted to do in the following week. Participants were then randomly assigned to mentally elaborate on these activities and focusing on its positive outcomes either using mental imagery or logical thinking. Before and after doing this activity elaboration exercise, participants reported their feelings and expectations about these activities. Over the next week, they recorded how often they engaged in their specific chosen activities, as well as any other pleasurable activities.

The findings indicate that participants in both the mental imagery and logical thinking mental elaboration groups had more positive expectations about their chosen activities after the lab task, and completed similar numbers of these activities in the following week, regardless of participants' level of depressed mood. This suggests that both strategies might motivate action, but more research is needed to understand how they work and what drives this behaviour.

Investigating the Effect of Mental Imagery Future Based Episodic Simulation on Subsequent Behavioural Engagement in Depressed, Dysphoric and Non-Depressed Individuals

The use of positive mental imagery as a possible technique for improving depressed mood (e.g., Blackwell & Holmes, 2010; Lang et al., 2012) and future thinking (e.g., Boland et al., 2018; Hallford et al., 2023) has recently received growing empirical attention. Mental imagery is the simulation or re-creation of perceptual experience that can involve a variety of sensory modalities, e.g., visual (sight) and olfactory (smell) perceptions (Kosslyn et al., 2001). Mental imagery appears to have a stronger effect on emotion than verbal processing (Holmes & Mathews, 2005), possibly because mental images are rated as more real than verbal thoughts (Mathews et al., 2013). Mental imagery-based episodic simulation refers to the ability individuals have to mentally time travel and pre-experience a future event along with its affective consequences (D'Argembeau & Van Der Linden, 2004; Schacter et al., 2008), which could motivate positive future behaviours by enhancing a sense of reward, motivation, and anticipation of pleasure (Hallford et al., 2020), potentially leading people to ultimately choose to engage in positive behaviours.

Recent studies have started to investigate the impact of mental imagery-based episodic simulation on motivation and behavioural engagement. Renner et al. (2019) specifically addressed planned reward activities (activities that can give individuals a sense of reward once completed) in a community sample. Participants self-nominated six activities to complete over the following week and were randomized to either a single-session Motivational Imagery condition, an Activity Reminder control condition, or a No-Reminder control condition. Relative to control groups, the Motivational Imagery group reported higher

levels of motivation, anticipated pleasure, and anticipated reward. The Motivational Imagery group also completed significantly more activities than the Activity Reminder group, but not more than the No-Reminder group. Ji et al. (2021) extended this work and found that mental imagery-based motivational elaboration led to higher behavioural activity engagement relative to the scheduling-only control condition, but only for high motivational barrier activities (high "putting off" activities). That study also showed that anticipatory pleasure (present moment) rather than anticipated pleasure (expected in the future) was the primary factor in amplifying motivation via mental imagery. A similar recent study also showed increases in motivation for an imagery group relative to control groups but failed to find a superior effect on increasing specific planned behaviours, even compared to a text reminder only condition (Heise et al., 2022). These studies provide preliminarily, albeit mixed evidence that mental imagery-based episodic simulation can increase motivation and may increase behavioural engagement for specific behaviours in daily life in the general population.

Researchers have also begun to investigate the role of mental imagery-based episodic simulation in increasing behavioural activity engagement in depression, yielding mixed findings. Drawing secondary data from a Randomized Controlled Trial (Blackwell et al. 2015), Renner et al. (2017) compared a 4-week positive imagery intervention to a non-imagery control condition and measured behavioural activation five times over 6 months. Behavioural activation scores increased over time in both groups with a greater increase at earlier time points in the imagery condition. Similar effects were found for a two-session future thinking program promoting imagery use at a three-month follow-up on general behavioural activation among people with major depression (Hallford et al., 2023). Notably, behavioural activation in these studies was measured using standardised questionnaires of behavioural activation. Whilst these are designed to measure the extent to which an

individual perceives they have been engaging in rewarding and meaningful activities, they do not assess the frequency with which an individual actually engaged in specific planned activities. It is therefore not clear how a focus on imagery for specific planned behaviours translates to engagement in those same behaviours.

A more recent study has contemporaneously measured behaviour following mental imagery-based episodic simulation exercises in individuals with elevated depressive symptoms. Participants were either randomly allocated to a mental imagery group or an active control group performing relaxation exercises over 10 days (Bar et al., 2024). Compared to relaxation, mental imagery enhanced motivation and reward anticipation, but not behaviour. The authors noted two possible explanations; the focus of the assessment on behaviour in general rather than on execution of the planned activity explicitly, and potentially over-narrow or broad interpretations by participants of being 'active' (something the current study aimed to address). Lastly, using ecological momentary assessment (EMA), Hallford et al. (2020) asked whether the use of imagery-based future thinking for near-future behaviours throughout the day increased the likelihood of engaging in these specific behaviours among people with major depression. Although detail, imagery and anticipatory pleasure for these future behaviours increased, no effect on behavioural engagement was found.

Thus, recent studies on mental imagery-based episodic simulation have shown mixed results regarding its impact on motivation and behavioural engagement. In the general population, mental imagery has been found to increase motivation and engagement in planned activities (e.g., Renner et al., 2019; Ji et al., 2021). In individuals with depression, mental imagery has shown some promise in boosting behavioural activation, but its influence

on engaging in specific planned activities is less consistent (Hallford et al., 2020; Bar et al., 2024). One consideration is whether effects are due to reward-focused activity elaboration in general, rather than imagery-based elaboration per se. Distinguishing these requires the use of an active control condition, such as the verbal elaboration condition used in Ji et al., (2021), matching the imagery elaboration condition on reward focus. Whilst Ji et al. (2021) found differences between these two active groups on the putative mechanisms that should lead to behavioural enactment, they found no difference in behavioural enactment. This may be related to an inadequate sample size to detect group effects, or perhaps low sensitivity to effects in an already normally-functioning community sample. A more effective test to distinguish these two reward-focused activities might use a sample that was larger, and therefore better powered to detect differences, and higher in depressive psychopathology – therefore potentially increasing sensitivity to effects on imagery and behavioural activity.

The present study

The present study aimed to extend prior research investigating the use of motivational mental imagery on behavioural engagement in reward activities in depression. Basing the design of the mental imagery and active control task on Ji et al. (2021), the present study compared the effects of a motivational mental imagery and an active control motivational verbal reasoning condition on self-reported expectancy (engagement, control, importance, motivation, effort), emotion (anticipated/anticipatory pleasure, momentary mood), and vividness ratings regarding *specific* chosen activities. The study then utilised EMA to assess behavioural engagement in these *specific* chosen activities in participants' daily life over a one-week period.

We hypothesised that, compared to the motivational verbal reasoning task, participants in the motivational mental imagery task would show greater improvements in self-reported expectancy, emotion, and vividness ratings from pre-to post experimental manipulation, and would engage in a greater number of chosen activities during their everyday lives. Further, we explored whether the magnitude of these hypothesised effects would be smaller for individuals with higher depression symptoms due to lower capacity to engage in the imagery condition, given prior research indicating impoverished positive mental imagery generation in depression (Holmes et al., 2016).

In addition, we also explored behavioural engagement for any other "pleasurable" activities that were not used in the experimental task to investigate whether the experimental tasks influenced behavioural engagement beyond the specific activities selected. It was hypothesised that, compared to the motivational verbal reasoning task, participants in the motivational mental imagery task would engage in a greater number of other pleasurable activities during their everyday lives, and we also aimed to explore whether the magnitude of these hypothesised effects differed across the three mood groups.

Method

Participants

163 participants (44 males), with an age range of 18–87 years (M = 31.01, SD = 14.86), participated in exchange for course credits or a £20 Love2Shop voucher. All participants provided informed consent, and the procedures were approved by the School of Education, Language and Psychology Research Ethics Committee [RECPSY00065].

Participants' current depression status was established based on their profile on the Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer & Williams, 1999). 52 participants met criteria for either moderate, moderately severe, or severe depression symptom levels and formed the depressed group[1]. A further 46 participants met criteria for mild depression symptom levels and formed a dysphoric group. Finally, 65 participants did not meet the threshold criteria for clinically significant depression symptom levels and formed the non-depressed control group.

Design

The study consisted of two parts: an online experimental session and an activity week during participants' everyday lives. The online experimental session employed a 2 (Time; pre vs post experimental task) x 3 (Mood group; non-depressed vs dysphoric vs depressed) x 2 (Experimental Task; Motivational Mental Imagery vs Motivational Verbal Reasoning) mixed design, with between subjects employed on the final two factors. Qualtrics randomly assigned participants to one of the two experimental tasks. Dependent variables were the ratings made by participants before and after the Activity Rating Task, and endorsement of whether activities were engaged in or not over the activity week. A power analysis was conducted to determine the sample size required. The power analysis was conducted based on the 3 (Mood group) x 2 (Experimental Task) interaction. Using G Power 3.1 software, a sample size of 158 was required to provide adequate power (0.8) to detect a medium effect.

Materials

[1] We did not establish whether any of the participants within this group had a clinical diagnosis of depression. We use "depressed group" as a distinction from participants in the other two groups who scored significantly less on the PhQ-9.

The Patient Health Questionnaire (PHQ-9; Kroenke et al., 1999). The PHQ-9 is a 9-item inventory used to assess the presence of depressive symptoms as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 2013). Each item on the inventory is scored using a four-point scale with respect to the extent the individual has experienced that symptom over the previous 2-week period: 0 = Not at all; 1 = several days; 2 = more than half the days, 3 = Nearly every day. Summation of responses provides a total score between 0 and 27. A score between 0-4 indicates no depressive symptoms, 5-9 indicates mild depression, 10-14 indicates moderate depression, 15-19 indicates moderately serve depression, and 20-17 indicates severe depression. The PHQ-9 has shown good psychometric properties for identifying probable depression and assessing the severity of depressive symptoms (Kroenke et al., 2001).

Activity Selection. In the Activity Selection phase, participants were prompted to select four activities from a list of thirty (see Appendix A) that they would like to engage more with. It was stipulated that they must not already be a part of participants' daily/weekly routine, they must not require extensive preparation, and the activities must be able to be done for ten minutes or more.

Activity Rating Task. For each activity, participants made ratings on how likely they were to engage with the activity in the future (likelihood), how much control they had over engaging with the activity (perceived control), how important engaging in the activity was to them (importance), how motivated they were to engage with the activity (self-reported-motivation), how much effort they thought engaging in the activity would require (perceived effort), how much pleasure they felt right now thinking about engaging with the activity (anticipatory pleasure), and how much pleasure they thought they would feel if they engaged with the activity (anticipated pleasure). Participants were also required to rate how vividly

they could imagine engaging with the activity (vividness). Each rating was made on a 7-point scale, with 0 being the least and 6 being the highest.

Momentary Mood. Positive and negative momentary mood were assessed using two visual analogue scales as used by Nelis at el., (2015). To measure positive mood, scores ranged from totally not in a positive mood (0) to in a very positive mood (100). To measure negative mood, scores ranged from totally not dejected, down, sad, depressed (0) to very dejected, down, sad, depressed (100). Participants had to indicate how they felt in the moment.

Motivational Mental Imagery Task. Adapted from Ji et al., (2021), the imagery audio script required participants to vividly imagine themselves performing each of their chosen activities. Participants were instructed to close their eyes during the imagery task and to focus on the most positive aspects of their image while imagining themselves doing the activity. The audio guide directed participants through imagining the context of the activity (e.g. location), the multi-sensory aspects of engaging with their activity (e.g. visual, auditory, sensory), and the most powerful aspect that make them want to do the activity. To encourage participants to follow the instructions, they were required to answer the following questions at the end of the task: “What did you see in your imagination?”, “What sounds did you hear?”, “What bodily sensations did you feel?” and “What feelings did you experience?”.

Motivational Verbal Reasoning Task. Adapted from Ji et al., (2021), the verbal reasoning audio script required participants to engage with in verbal analytical thinking about the benefits of their chosen activities and why they should engage in the activity. To encourage participants to follow the instructions, they were required to answer the following questions at the end of the task: “Think about the most logical reasons why you should follow through with the plan for this activity. What are they?”; “As accurately as you can, predict the

benefits of completing this activity"; "What positive emotional consequences might there be, if any, of completing this activity", "Analyse why the benefits of this activity might outweigh the effort (e.g. mental, physical, time) required to complete the activity".

Daily Activity Engagement Diary. Participants received an email (via Qualtrics), or a notification (via SEMA3; O'Brien et al., 2024) at 8pm each night of the activity week. They were required to answer yes or no to two questions: "did you engage with any of your chosen activities in the previous 24 hours?" and "did you engage with any other pleasurable activities in the previous 24 hours?", to indicate whether they engaged with any activities or not (irrespective of how many).

Procedure

The experimental tasks were presented on Qualtrics. Participants either took part in a psychology lab (n=56), or via a video call on MS Teams (n=107), with a researcher present in both. Following the consent procedure, participants completed the PHQ-9 and the momentary mood scale. Participants then completed the activity section and activity rating tasks. Participants then either completed the motivational mental imagery task or the motivational verbal reasoning task, followed by the activity rating task and the momentary mood scale for a second time. Over the next 7 days, participants completed the daily activity engagement diary.

Results

Participant demographics. A one-way ANOVA established the three groups differed significantly with respect to PHQ-9 scores, $F(2,162) = 336.08$, $p < 0.001$. The depressed group scored significantly higher (M=13.38, SD=3.57) compared with both the dysphoric

(*M*=6.91, *SD*=.31) and non-depressed groups (*M*=2.45, *SD*=1.24); additionally, the dysphoric group scored significantly higher than the non-depressed group (all *ps* < 0.001).

To assess the change in each rating for participants chosen activities, a 2 (Time: pre- vs. post-experimental task) x 2 (Experimental Task: Motivational Mental imagery vs. Motivational Verbal reasoning) x 3 (Mood group: Non-depressed vs. Dysphoric vs. Depressed) mixed ANOVA was conducted, with repeated measures on the first factor. Bonferroni adjusted pairwise comparisons were conducted, where required, to clarify the nature of significant effects. Descriptive statistics are displayed in Table 1.

[Insert table 1 here]

Likelihood of Engagement. A significant main effect emerged for Time $F(1,157)=132.42$, $p < .001$, $\eta p2 = .46$, with likelihood of engagement being predicted as more likely post experimental task. There were no other significant main effects or interactions ($Fs \leq 2.32$, $ps \geq .10$, $\eta p2s \leq .03$).

Perceived Control. A significant main effect emerged for Time $F(1,157)=7.34$, $p = .007$, $\eta p2 = .05$, with activities being predicted as more controllable post experimental task. There were no other significant main effects or interactions ($Fs \leq 2.49$, $ps \geq .086$, $\eta p2s \leq .03$).

Importance. A significant main effect emerged for Time $F(1,157)=37.66$, $p = .001$, $\eta p2 = .19$, with activities being predicted as more important post experimental task. There were no other significant main effects or interactions ($Fs \leq 2.26$, $ps \geq .30$, $\eta p2s \leq .03$).

Self-Reported Motivation. A significant main effect emerged for Time $F(1,157)=46.02$, $p = .001$, $\eta p2 = .23$, with motivation increasing post experimental task. A Time x Mood group interaction also emerged $F(2,157)=4.49$, $p=.011$, $\eta p2=.23$. Bonferroni

pairwise comparisons revealed pre-experimental task the non-depressed participants had significantly more motivation compared to the dysphoric participants (p=.027), with no difference post-experimental task (p=1.00). There were no other significant main effects or interactions ($Fs \leq 1.54$, $ps \geq .059$, $\eta p2s \leq .02$).

Perceived Effort. A significant main effect emerged for Time $F(1,157)=5.32$, p =.022, $\eta p2$ = .03, with perceived effort of doing the activity decreasing post experimental task. There were no other significant main effects or interactions ($Fs \leq 1.80$, $ps \geq .17$, $\eta p2s \leq .02$).

Anticipatory pleasure. A significant main effect emerged for Time $F(1,157)=35.32$, p <.001, $\eta p2$ = .18, with anticipatory pleasure increasing post experimental task. A main effect of Mood group also emerged $F(2,157)=10.14$, p =.047, $\eta p2$ = .04, demonstrating that non-depressed participants had higher anticipatory pleasure compared to the dysphoric participants across time-points and experimental task (p =.041), with no difference between the non-depressed and the depressed mood groups (p =.85), or the dysphoric and depressed mood groups (p =.50). There were no other significant main effects or interactions ($Fs \leq 2.47$, $ps \geq .20$, $\eta p2s \leq .01$).

Anticipated pleasure. A significant main effect emerged for Time $F(1,157)=29.61$, p <.001, $\eta p2$ = .16, with anticipated pleasure increasing post experimental task. A Time x Mood group interaction also emerged $F(2,157)=3.87$, p =.023, $\eta p2$ = .05. Bonferroni pairwise comparisons revealed a significant increase over time in anticipated pleasure for both the dysphoric and depressed groups only (p<.001 & p=.010 respectively), as depicted in Figure 1. There were no other significant main effects or interactions ($Fs \leq 2.63$, $ps \geq .076$, $\eta p2s \leq .03$).

[Insert Figure 1 here]

Positive Momentary mood. A significant main effect emerged for Time $F(1,157)=35.83$, $p < .001$, $\eta p2 = .19$, with positive momentary mood increasing post experimental task. There was also a main effect for Mood group, $F(2,157)=53.26$, $p < .001$, $\eta p2 = .40$, with both non-depressed and dysphoric participants reporting higher levels of positive momentary mood compared to depressed participants (both $ps < .001$), and the non-depressed having higher levels of positive momentary mood compared to dysphoric participants ($p=.007$). There were no other significant main effects or interactions ($Fs \leq 2.07$, $ps \geq .058$, $\eta p2s \leq .01$).

Negative Momentary mood. A significant main effect emerged for Time $F(1,157)=32.80$, $p < .001$, $\eta p2 = .17$ with negative momentary mood decreasing post experimental task. There was also an effect for Mood group $F(2,157)=32.79$, $p < .001$, $\eta p2 = .30$, with both non-depressed and dysphoric participants reporting lower levels of negative momentary mood compared to depressed participants (both $ps < .001$), and the non-depressed having lower levels of negative momentary mood compared to dysphoric participants ($p=.037$). A significant 3-way interaction also emerged $F(2,157)=3.06$, $p = .05$, $\eta p2 = .04$ (see Figure 2). Bonferroni pairwise comparisons revealed that in the Imagery task negative mood decreased in the dysphoric and depressed mood groups only ($p=.033$ & $p<.001$ respectively), whereas in the verbal reasoning task negative mood decreased for the non-depressed and dysphoric mood groups only ($p=.009$ & $p=.045$ respectively). There were no other significant main effects or interactions ($Fs \leq 1.83$, $ps \geq .18$, $\eta p2s \leq .02$).

[Insert Figure 2 here]

Vividness ratings. A significant main effect emerged for Time $F(1,157)=36.54$, $p < .001$, $\eta p2 = .19$, with vividness ratings increasing post experimental task. There were no other significant main effects or interactions ($Fs \leq 3.34$, $ps \geq .069$, $\eta p2s \leq .02$).

To assess behavioural engagement levels over the one-week activity period, two 2 (Experimental Task: Motivational Mental Imagery vs. Motivational Verbal Reasoning) x 3 (Mood group: Non-depressed vs. Dysphoric vs. Depressed) between subjects ANOVA was conducted on participants chosen activities and any other pleasurable activities. Due to some technical issues in the early stages of data collection, not all participants received surveys to complete each day. Given the differing numbers of surveys received across participants, we converted the activity count into percentages. Notably, only participants who received five or more (out of seven) consecutive notifications to record their data were included in the final data set. Descriptive statistics are displayed in Table 2.

[Insert table 2 here]

Behavioural Engagement: Chosen Activities. No significant main effects for Experimental Task $F(1,157)=.30$, $p=.58$, $\eta p2 = .002$ nor Mood group $F(2,157)=1.37$, $p=.26$, $\eta p2 = .02$ emerged, nor a significant interaction $F(2,157)=.04$, $p=.96$, $\eta p2 = .001$, depicted in Figure 3.

[Insert Figure 3 here]

Behavioural Engagement: Other Pleasurable Activities. There was no significant main effect for Experimental Task $F(1,157)=.02$, $p=.88$, $\eta p2 = .000$. A significant main effect for Mood group emerged $F(2,157)=3.51$, $p=.032$, $\eta p2 = .04$, with the non-depressed participants engaging with significantly more activities, beyond their chosen activities, compared to the depressed participants ($p=.038$). No significant interaction emerged $F(2,157)=.1.66$, $p=.19$, $\eta p2 = .02$.

Discussion

This study tested the effects of motivational mental imagery against an active motivational verbal reasoning control condition on expectancy/emotion ratings and behaviour in individuals varying in depressive symptomatology. Self-reported ratings of engagement, control, importance, effort, motivation/anticipated pleasure, anticipatory pleasure, and vividness increased to similar degrees across conditions. However, negative mood was reduced in the mental imagery condition only for depressed and dysphoric participants and for non-depressed and dysphoric participants only following the verbal reasoning task. This suggests that in depression, mental imagery may have a superior capacity to impact emotion, consistent with previous findings (e.g., Holmes & Mathews, 2005).

The lack of disparity between the two experimental tasks has also been noted in previous research measuring anticipated motivation (Ji et al., 2021). One possible explanation may be that during the verbal reasoning task, participants not only thought about the benefits of and reasons for engagement in their chosen activities as requested, but also employed mental imagery, which can occur spontaneously and voluntarily (e.g., Cole & Kvavilashvili, 2019). When individuals are asked to think about pleasurable activities, they tend to engage in mental imagery to a similar extent irrespective of explicit instruction to do so (Ji et al., 2024). Alternatively, the verbal reasoning condition may have active components that have similar effects to mental imagery. Previous studies assessing belief in occurrence suggest that reasoning (explaining why a particular outcome will come about) increases the perceived likelihood of that outcome (see Koehler, 1991 for a review). Our verbal reasoning task required participants to explore the reasons why they should engage with their chosen activities, which could have enhanced both their expectancy and emotion. Future research should aim to establish to what extent mental imagery is being used within the different tasks; however, even if participants across both tasks report that they experienced mental imagery, there may be qualitative differences in this imagery in terms of content and function.

Therefore, future research should go beyond attempts to measure quantity of imagery use during the tasks and ask about the content and characteristics of such imagery.

A surprising finding was that the non-depressed and dysphoric mood groups showed significant differences in their anticipatory pleasure ratings, while no such differences were observed between the non-depressed and depressed mood groups. Furthermore, we did not find support for our hypothesis that the non-depressed mood group would show an increase in anticipated pleasure. Further research could address the possibility that participants had already considered engaging with these activities prior to the experiment, such that their anticipated pleasure was already established.

We found no significant difference between conditions in terms of participants' behavioural engagement in their everyday lives over the week following the experiment, consistent with previous findings failing to show simple and consistent effects for imagery on specific behaviours (e.g., Bar et al., 2024; Heise et al., 2022; Hallford et al., 2020; Ji et al., 2021; Renner et al., 2017). However, there was also no significant difference across the three mood groups (across both experimental tasks), indicating that all mood groups engaged with their chosen activities to a similar extent. This is an encouraging finding, as one of the symptoms of depression is diminished engagement in pleasurable activities (Peeters et al., 2003; Carvalho & Hopko, 2011).

We found no significant difference across tasks in engagement in 'pleasurable' activities not featuring in the activity selection task: that is, in broader behavioural engagement (i.e., a carryover effect to other pleasurable activities). However, across conditions, non-depressed participants engaged in significantly more additional pleasurable activities than depressed participants. Thus, for individuals with depression, behavioural engagement may be limited to the specific activities with which they have mentally engaged.

Another plausible explanation is that the groups may have had different behavioural activity levels prior to the experimental tasks, and the experimental task caused differential *change* during the activity week. Since pre-experimental tasks behavioural activity levels were not measured, this cannot be ascertained, but findings from other studies indicate it is possible (e.g., Renner et al., 2017; Hallford et al., 2023).

Limitations and Future Directions

There are several limitations in the present study that warrant caution when interpreting the results. First, although the aim of the study was to test the specificity of mental imagery-based activity elaboration on behavioural engagement by contrasting it against an active control condition (verbal reasoning), for feasibility reasons we did not additionally employ a passive control group. As such, the impact of mental imagery and verbal reasoning-based elaboration relative to no activity elaboration remains to be established in non-depressed, dysphoric, and depressed individuals, and the results should be interpreted with caution.

Second, as discussed earlier, we did not measure mental imagery engagement during the experimental tasks, making it difficult to determine whether participants in the verbal reasoning task also engaged with mental imagery, and if they did, whether there were any qualitative differences. Similarly, as part of the activity rating task, participants were asked to rate how vividly they could imagine their chosen activities, both before and after the experimental tasks. This may have unintentionally primed them to use mental imagery. Future research should take care to avoid inadvertently prompting participants to use imagery in conditions unrelated to mental imagery to resolve this ambiguity, and should include manipulation checks to assess whether participants are engaging with the conditions as expected.

Third, although our findings indicate that the depressed and dysphoric groups did not engage in fewer activities than the non-depressed group, it remains unclear whether inherent differences in activity engagement exist between the groups or whether the experimental tasks promoted comparable levels of engagement across all participants. Future studies should determine baseline activity levels.

Fourth, the daily question participants received about their activity engagement assumed participants remembered the activities they selected at the beginning of the study, which may not have been the case for all participants. Future studies should ensure the activities selected are incorporated into this question as a reminder.

Finally, while participants chose their activities, they were limited to a predefined list. This may have restricted the tasks' impact if participants struggled to find activities they wanted to engage in. Future studies could allow participants to come up with their own activities.

Conclusion

In summary, present results demonstrate that motivational mental imagery and verbal reasoning-based elaboration of activities had similar positive impacts on expectancy and emotion ratings and resulted in similar behavioural activity engagement levels across participants, irrespective of depression symptom level. Research is now needed to try to understand the potential underlying mechanism/s by which behavioural engagement is occurring.

CRediT authorship contribution statement

Jennifer Shevchenko – Conceptualization; Investigation; Methodology; Supervision; Project Administration; Data curation; Formal Analysis; Writing – original draft; **Julie L. Ji** - Conceptualization; Methodology; Writing – review & editing; **Scott N. Cole** – Conceptualization; Writing – review & editing; **Fritz Renner** – Conceptualization; Methodology; Writing – review & editing; **David J. Hallford** – Conceptualization; Methodology Supervision; Writing – review & editing.

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References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Bär, A., Heininga, V. E., Lemmens, L. H., & Renner, F. (2024). From anticipation to action: A RCT on mental imagery exercises in daily life as a motivational amplifier for individuals with depressive symptoms. *Applied Psychology: Health and Well-Being*. https://doi.org/10.1111/aphw.12572

Boland, J., Riggs, K. J., & Anderson, R. J. (2018). A brighter future: The effect of positive episodic simulation on future predictions in non-depressed, moderately dysphoric & highly dysphoric individuals. *Behaviour Research and Therapy, 100,* 7-16. https://doi.org/10.1016/j.brat.2017.10.010

Blackwell, S. E., Browning, M., Mathews, A., Pictet, A., Welch, J., Davies, J., & Holmes, E. A. (2015). Positive imagery-based cognitive bias modification as a web-based treatment tool for depressed adults: a randomized controlled trial. *Clinical Psychological Science, 3*(1), 91–111. doi:10.1177/2167702614560746.

Carvalho, J. P., & Hopko, D. R. (2011). Behavioral theory of depression: Reinforcement as a mediating variable between avoidance and depression. *Journal of Behavior Therapy and Experimental Psychiatry, 42*(2), 154–162. https://doi.org/10.1016/j.jbtep.2010.10.001.

Cole, S. N. and Kvavilashvili, L. (2019). Spontaneous future cognition: The past, present and future of an emerging topic. *Psychological Research, 83*(4), 631-650. doi: https://doi.org/10.1007/s00426-019-01193-3

D'Argembeau, A., & Van Der Linden, M. (2004). Phenomenal characteristics associated with projecting oneself back into the past and forward into the future: Influence of valence and temporal distance. *Consciousness and Cognition, 13*(4), 844–858. https://doi.org/10.1016/j.concog.2004.07.007.

Hallford, D. J., Rusanov, D., Yeow, J. J. E., Austin, D. W., D'Argembeau, A., Fuller-Tyszkiewicz, M., & Raes, F. (2023). Reducing anhedonia in major depressive disorder with future event specificity training (FEST): a randomized controlled trial. *Cognitive Therapy and Research*, *47*(1), 20-37. https://doi.org/10.1007/s10608-022-10330-z

Hallford, D. J., Sharma, M. K., & Austin, D. W. (2020). Increasing anticipatory pleasure in major depression through enhancing episodic future thinking: A randomized single-case series trial. *Journal of Psychopathology and Behavioral Assessment*, 42(4), 751-764. https://doi.org/10.1007/s10862-020-09820-9

Heise, M., Werthmann, J., Murphy, F., Tuschen-Caffier, B., & Renner, F. (2022). Imagine how good that feels: The impact of anticipated positive emotions on motivation for reward activities. *Cognitive Therapy and Research*, *46*(4), 704-720. https://doi.org/10.1007/s10608-022-10306-z

Holmes, E. A., Blackwell, S. E., Burnett Heyes, S., Renner, F., & Raes, F. (2016). Mental imagery in depression: Phenomenology, potential mechanisms, and treatment implications. Annual review of clinical psychology, 12(1), 249-280. 10.1146/annurev-clinpsy-021815-092925

Holmes, E. A., & Mathews, A. (2005). Mental imagery and emotion: A special relationship? *Emotion, 5*(4), 489–497. https://doi.org/10.1037/1528-3542.5.4.489.

Ji, J. L., Woud, M. L., Rölver, A., Notebaert, L., Todd, J., Clarke, P. J. F., … Blackwell, S. E. (2024). Investigating the role of mental imagery use in the assessment of anhedonia. Cognition and Emotion, 1–19. https://doi.org/10.1080/02699931.2024.2405008

Ji, J. L., Geiles, D., & Saulsman, L. M. (2021). Mental imagery-based episodic simulation amplifies motivation and behavioural engagement in planned reward activities. *Behaviour Research and Therapy, 145*, 103947. https://doi.org/10.1016/j.brat.2021.103947

Koehler, D. J. (1991). Explanation, imagination, and confidence in judgment. *Psychological bulletin*, *110*(3), 499-519.

Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2001). Neural foundations of imagery. *Nature Reviews Neuroscience*, *2*, 635. https://doi.org/10.1038/35090055.

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of general internal medicine*, *16*(9), 606-613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kroenke, K., Spitzer, R. L., & Williams, J. B. (1999). Patient health questionnaire-9. *Cultural Diversity and Ethnic Minority Psychology*. https://doi.org/10.1037/t06165-000

Lang, T. J., Blackwell, S. E., Harmer, C. J., Davison, P., & Holmes, E. A. (2012). Cognitive Bias Modification Using Mental Imagery for Depression: Developing a Novel Computerized Intervention to Change Negative Thinking Styles. *European Journal of Personality, 26*, 145–157. DOI: 10.1002/per.855

564 Mathews, A., Ridgeway, V., & Holmes, E. A. (2013). Feels like the real thing: Imagery is
565 both more realistic and emotional than verbal thought. *Cognition and Emotion, 27*(2),
566 217–229. doi:10. 1080/02699931.2012.698252.

567 Nelis, S., Holmes, E. A., Palmieri, R., Bellelli, G., & Raes, F. (2015). Thinking back about a
568 positive event: The impact of processing style on positive affect. *Frontiers in*
569 *psychiatry, 6,* 3. https://doi.org/10.3389/fpsyt.2015.00003

570 O'Brien, S. T., Dozo, N., Hinton, J. D. X., Moeck, E. K., Susanto, R., Jayaputera, G. T.,
571 Sinnott, R. O., Vu, D., Alvarez-Jimenez, M., Gleeson, J., & Koval, P. (2024).
572 SEMA3: A free smartphone platform for daily life surveys. *Behavior Research*
573 *Methods.* https://doi.org/10.3758/s13428-024-02445-w

574 Peeters, F., Nicolson, N. A., Berkhof, J., Delespaul, P., & De Vries, M. (2003). Effects of
575 daily events on mood states in major depressive disorder. *Journal of Abnormal*
576 *Psychology, 112*(2), 203–211. https://doi.org/10.1037/0021-843X.112.2.203.

577 Renner, F., Ji, J. L., Pictet, A., Holmes, E. A., & Blackwell, S. E. (2017). Effects of engaging
578 in repeated mental imagery of future positive events on behavioural activation in
579 individuals with major depressive disorder. *Cognitive Therapy and Research, 41*(3),
580 369–380. https://doi.org/10.1007/s10608-016-9776-y

581 Renner, F., Murphy, F. C., Ji, J. L., Manly, T., & Holmes, E. A. (2019). Mental imagery as a
582 "motivational amplifier" to promote activities. *Behaviour Research and Therapy, 114,*
583 51–59. https://doi.org/10.1016/j.brat.2019.02.002.

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events. *Annals of the New York Academy of Sciences, 1124*(1), 39–60. https://doi.org/10.1196/annals.1440.001.

Appendix A

1. Cooking
2. Going for a walk
3. Meditation
4. Reading
5. Listening to a podcast
6. Playing a game
7. Going for a coffee
8. Playing a musical instrument
9. Going for a meal
10. Baking
11. Going for a run
12. Phoning a family member or friend
13. Going to the cinema
14. Waking up earlier, and getting ready at a leisurely pace
15. Star gazing
16. Painting/drawing/cooking
17. Swimming
18. Going to the gym
19. Yoga
20. Listening to music
21. Watching a boxset
22. Meeting friends
23. Going to an exercise class
24. Attending a quiz
25. Having a picnic
26. Doing a jigsaw puzzle
27. Doing some self-care
28. Learning a new language
29. watching the sunset or sunrise
30. Dancing

633 **Table 1:** Mean expectancy, emotion, and vividness ratings (and standard deviations) as a function of time, experimental task, and depression status.

	Experimental Task	Non-Depressed		Dysphoric		Depressed	
		Pre	Post	Pre	Post	Pre	Post
Likelihood	Imagery	4.14 (1.50)	5.00 (1.46)	4.33 (1.36)	4.89 (1.49)	4.58 (1.23)	5.21 (1.14)
	Verbal Reasoning	4.52 (1.36)	5.37 (1.07)	3.55 (1.22)	4.39 (1.08)	4.24 (1.45)	4.94 (1.47)
Control	Imagery	4.94 (1.48)	5.04 (1.62)	5.64 (1.00)	5.71 (1.21)	5.25 (1.11)	5.38 (1.01)
	Verbal Reasoning	5.27 (1.10)	5.63(0.99)	5.08 (1.17)	5.22 (1.13)	5.03 (1.33)	5.24 (1.24)
Effort	Imagery	4.37 (1.23)	4.18 (1.38)	4.67 (1.30)	4.51 (1.25)	4.68 (1.14)	4.67 (1.36)
	Verbal Reasoning	4.38 (1.09)	4.46 (1.11)	4.56 (0.79)	4.16 (0.90)	4.59 (0.96)	4.24 (1.03)
Motivation	Imagery	4.92 (1.14)	5.15 (1.12)	4.85 (0.94)	5.43 (1.04)	4.88 (1.19)	5.15 (1.13)
	Verbal Reasoning	5.12 (1.05)	5.45 (1.06)	4.09 (1.18)	4.97 (0.84)	4.94 (0.90)	5.29 (0.91)
Importance	Imagery	4.58 (1.23)	4.99 (1.25)	4.73 (0.88)	4.97 (1.02)	4.93 (1.14)	5.28 (1.16)
	Verbal Reasoning	5.08 (0.98)	5.49 (1.03)	4.44 (1.05)	4.80 (1.06)	4.90 (0.87)	5.01 (0.92)
Anticipatory Pleasure	Imagery	5.05 (1.05)	5.43 (0.95)	4.84 (0.99)	5.38 (1.03)	4.78 (1.07)	5.17 (1.06)
	Verbal Reasoning	5.38 (0.92)	5.58 (0.92)	4.53 (0.82)	4.95 (1.17)	5.28 (0.90)	5.49 (0.85)
Anticipated Pleasure	Imagery	5.49 (1.02)	5.63 (1.01)	5.10 (0.76)	5.67 (0.80)	5.27 (1.05)	5.56 (0.98)
	Verbal Reasoning	5.67 (0.73)	5.78 (0.82)	5.05 (0.74)	5.44 (0.85)	5.72 (0.75)	5.91(0.58)
Positive Mood	Imagery	81.24 (11.36)	83.68 (13.06)	68.92 (19.29)	74.96 (19.06)	50.32 (18.69)	60.28 (18.26)
	Verbal Reasoning	76.26 (12.74)	80.58 (13.99)	69.59 (8.79)	73.32 (13.07)	46.11 (20.64)	53.48 (17.90)
Negative Mood	Imagery	9.56 (11.99)	8.12 (11.98)	18.58 (19.00)	14.04 (13.59)	37.68 (23.81)	28.32 (19.27)
	Verbal Reasoning	14.19 (17.28)	9.26 (10.79)	22.50 (16.66)	18.05 (13.40)	38.41 (23.36)	35.04 (21.79)
Vividness	Imagery	5.43 (1.15)	5.82 (1.19)	5.67 (1.16)	5.86 (1.17)	5.18 (0.95)	5.86 (0.99)
	Verbal Reasoning	5.71 (0.85)	5.92 (0.86)	5.22 (0.85)	5.45 (1.00)	5.69 (0.87)	5.92 (0.86)

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Table 2: Percentage of activities completed (and standard deviations) as a function of experimental task and depression status.

Activities	Experimental Task	Non-Depressed	Dysphoric	Depressed
Chosen	Imagery	58.68 (32.28)	63.29 (29.24)	66.78 (33.04)
	Verbal Reasoning	59.49 (32.20)	67.45 (27.23)	69.89 (29.76)
Other	Imagery	79.76 (30.06)	69.35 (27.94)	62.19 (30.48)
	Verbal Reasoning	69.26 (21.81)	78.92 (27.25)	61.00 (33.30)

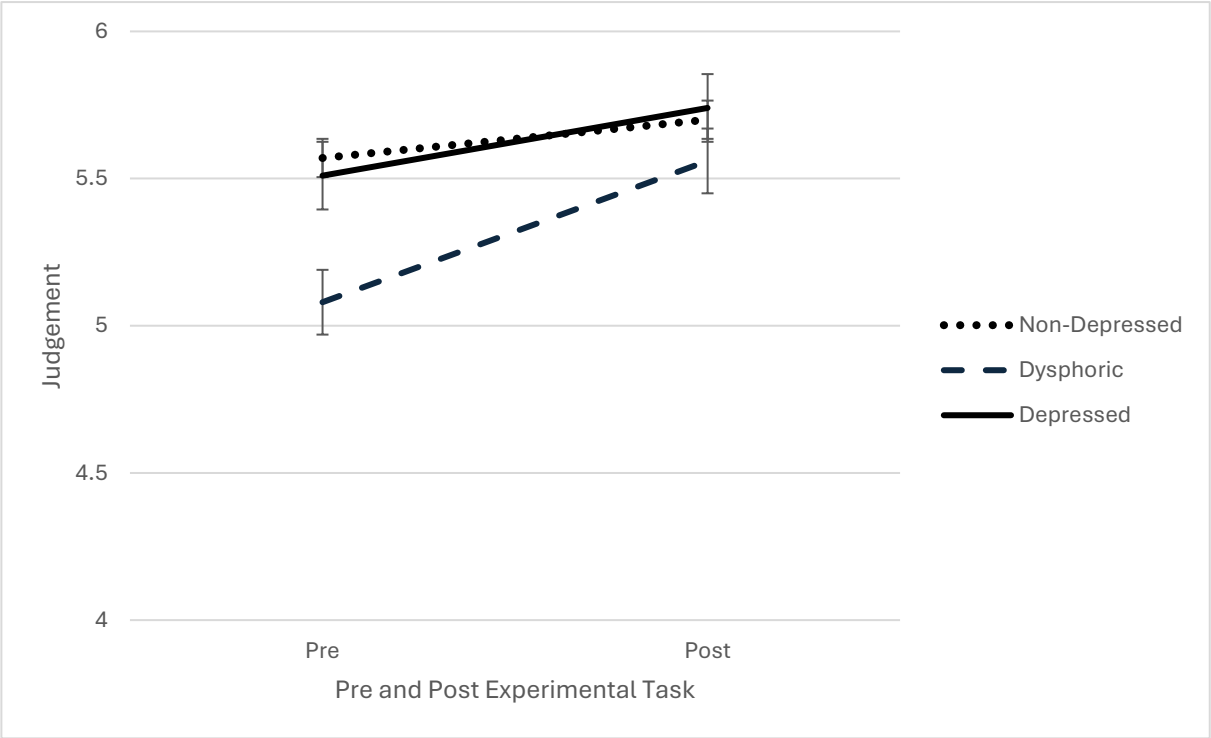

Figure 1: Mean anticipated pleasure as a function of time and depression status (across both experimental tasks). Error bars indicate standard error.

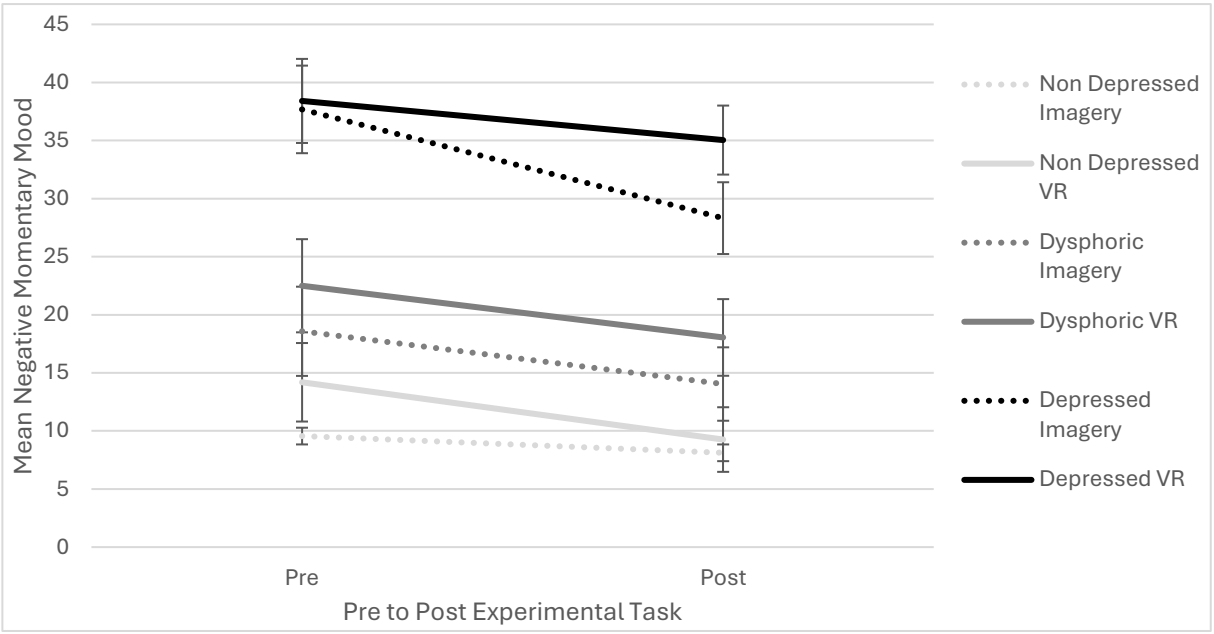

Figure 2: Mean negative momentary mood as a function of time, experimental task (VR=Verbal Reasoning) and depression status. Error bars indicate standard error.

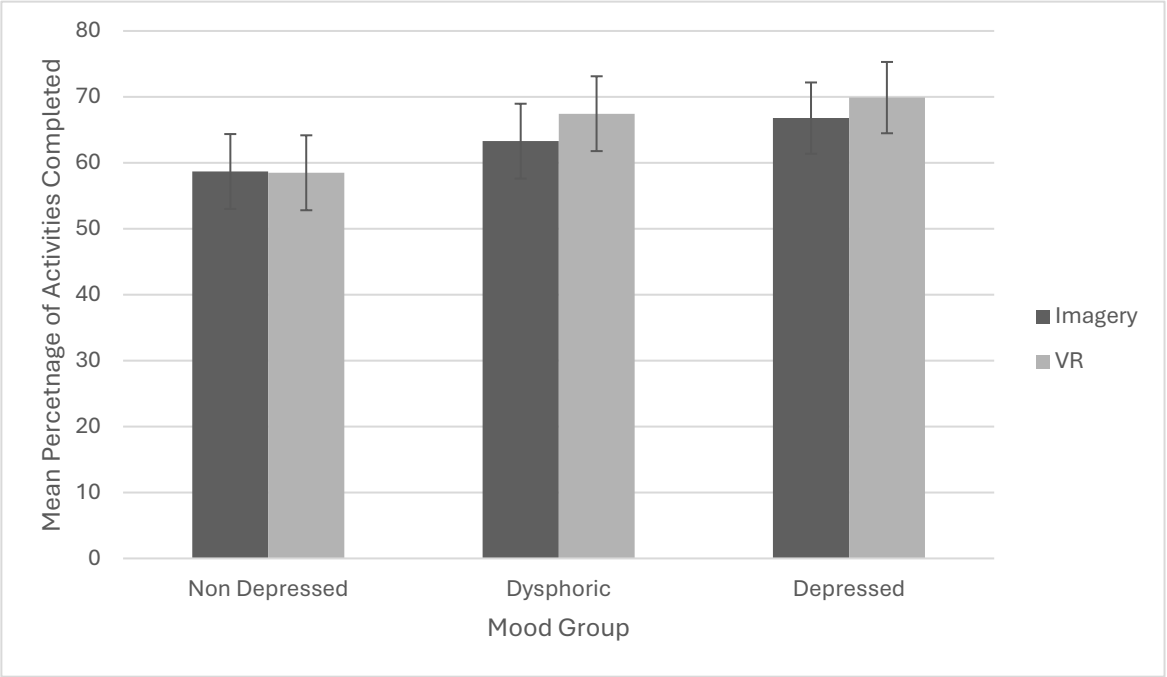

Figure 3: Mean Percentage of chosen activities completed as a function of experimental task (VR=Verbal Reasoning) and depression status. Error bars indicate standard error.