Emotion

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# Positive Autobiographical Memories to Counteract Low Mood in Remitted Depression: A Longitudinal Daily-Life Investigation

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Positive autobiographical memories (AMs) have the potential to repair low mood, but previously depressed individuals have difficulty leveraging their positive AMs for emotion regulation purposes. We examined whether previously depressed individuals benefit from guided, deliberate recollection of preselected AMs to counteract low mood in daily life, utilizing individuals' smartphones to facilitate recollection. Sixty participants enrolled in 2020 were randomly allocated to retrieval of positive or everyday activity AMs and completed ecological momentary assessment of emotional experience for 3 weeks. Participants first created a pool of six memories for the digital AM diary. This was followed by a training week with two recollection tasks daily and a 2-week follow-up period where the diary could be used spontaneously. The positive condition experienced a greater increase in feelings of happiness and a greater decrease in feelings of sadness from pre- to post-AM recollection. While participants in the positive condition used the AM technique more frequently overall during the 2-week follow-up, the effect of condition was moderated by changes in feelings of sadness. The more participants experienced an emotional benefit during the training week, the more they used it spontaneously. Emotional vividness of untrained positive AMs at the 2-week follow-up differed depending on whether they were assessed before or after the first pandemic lockdown. Residual depressive symptoms decreased in both conditions over the study course, while mental well-being remained unchanged. Strengthening positive, self-affirming AMs in daily life may provide a tool to support regulation of transient low mood in those remitted from depression.

*Keywords:* memory, emotion, emotion regulation, ecological momentary assessment, depression

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The data to reproduce the analyses are available as Supplemental Material.

Preregistration documents for this research can be accessed at https://osf.io/n36cu.

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Positive autobiographical memories (AMs) represent a rich resource for individual well-being (Miguel-Alvaro et al., 2021). Recollecting positive AMs evokes positive emotions associated with the memory and may link to new emotions experienced in the present moment (Kensinger & Ford, 2020). This is especially true when reliving AMs for central experiences in our lives (Holland & Kensinger, 2010). Positive AMs are important for building a positive sense of self (Westerhof et al., 2020), and the ease of their recollection is closely related to psychological well-being (S. E. Williams et al., 2022). Recollecting positive life experiences can be a protective factor in coping with emotional distress (Speer & Delgado, 2017, 2020), for example, in combating the transient low mood, which, if left unregulated, may trigger relapse in those remitted from depression (Teasdale, 1988).

However, the experience of depression is associated with reduced access to positive AMs (Hitchcock et al., 2020). When positive AMs are brought to mind, they tend to be egodystonic, not self-affirming, and diminished in detail and vividness (Dalgleish & Werner-Seidler, 2014). This is problematic for emotion regulation, as both the vividness of the positive AM and the extent to which it is perceived as consistent with one's current identity (i.e., individuals feel that they are the same person now as they were then) appear to be central to its positive effect on mood (Werner-Seidler et al., 2017). Individuals who are depressed or in remission but feel down may therefore benefit from repeated training to strengthen their positive memories (Everaert et al., 2022). Previous research has shown that by employing a multistep mnemonic technique, individuals with chronic depression can increase the quality of a preselected set of positive, self-affirming AMs and successfully use these AMs to elevate their mood (Dalgleish et al., 2013; Werner-Seidler & Dalgleish, 2016). Consequently, cultivating the ability to retrieve positive, self-affirming AMs at will holds promise for alleviating periods of low mood in individuals with recurrent depression. As over 50% of individuals who experience depression will later relapse (American Psychiatric Association, 2000), it is critical to develop techniques to support emotion regulation that are accessible and quick to complete (relative to established relapse prevention programs such as mindfulness-based cognitive therapy; J. M. G. Williams et al., 2014), such that they are easily integrated into everyday life.

Here, we sought to integrate science-driven AM recollection techniques into everyday life by utilizing an individual's smartphone to facilitate the recollection of positive AMs to regulate transient low mood. The present study is innovative in that it examines the emotion-regulating potential of positive AMs in daily life, in real time, using an ecological snapshot methodology (Trull & Ebner-Priemer, 2020). To train the ability to retrieve vivid, positive AMs for 1 week, individuals remitted from depression received daily smartphone-delivered reminders to complete a memory recall task (approximately 5 min), which guided recollection of preselected AMs in a vivid and imagery-rich fashion. For the following 2 weeks, we recorded participants unprompted use of the memory pool and the subsequent impact of recollection on feelings of happiness and sadness. We compared the effect of recollection of vivid, positively valanced memories with more benign, everyday AMs that were not strong in emotional intensity (hereinafter, everyday activity AMs). We reasoned that any effect of positive memory recollection would need to outperform the distracting effect of recalling a memory that was not high in emotional content. We did not use recall of negative memories as a control condition, as negative memory recollection would be anticipated to worsen mood, particularly in those with a history of depression, and thus comparison between positive and negative memory recollection would likely inflate the effects of positive memory recollection.

Our primary preregistered (https://osf.io/n36cu) hypothesis was that, during the training week, participants allocated to recall of positive AMs would experience a greater intraindividual increase in feelings of happiness from pre- to post-AM recollection, compared to individuals in the everyday activity condition. We further expected an intraindividual reduction of sadness in both the positive and everyday activity AM conditions, since everyday activity AMs may have a distracting effect. We hypothesized that this effect would strengthen over the course of the training week. Our second preregistered hypothesis was that any benefits from the recollection of positive AMs would generalize to untrained memories, such that following study completion, participants in the positive AM condition would more readily retrieve other, untrained positive AMs that were more positive in valence, evoke more happiness and satisfaction, be more vivid, and more self-concordant relative to those in the everyday activity condition. We also evaluated the potential of this technique for reducing risk of depressive relapse. To index acceptability and use, we hypothesized that individuals in the positive AM condition would demonstrate more frequent spontaneous (i.e., unprompted) use of the AM diary technique in the 2 weeks following training. We anticipated this effect would be stronger for those who experienced a greater improvement in feelings of happiness and a greater decrease in feelings of sadness during training (third preregistered hypothesis). To index potential effects on well-being, we explored whether those in the positive condition experienced an increase in well-being and a decrease in residual depressive symptoms from pre to post and to follow-up assessments, relative to the everyday activity condition (exploratory research question).

## Method

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

### Participants

The study was conducted in accordance with the Declaration of Helsinki and approved by the Cambridge University Research Ethics Committee (study title: *Enhancing Autobiographical Memories in Daily Life*; Protocol number: PRE.2019.077). Sixty-one participants were recruited from the MRC Cognition and Brain Sciences Unit panel of clinical research volunteers ($N$~550), who had previously responded to advertisements to participate in research. History of depression and current diagnostic status were determined using the structured clinical interview for the *Diagnostic and Statistical Manual of Mental Disorders, fifth edition* (First et al., 2015). Exclusion criteria were current major depressive episode, intellectual disability, traumatic brain injury, or current substance/alcohol use disorder. Volunteers were included if they met criteria for major depressive disorder and were currently in remission, were >= 18 years old, fluent in English, and had a personal smartphone. Participants were reimbursed £40 for participation. A Consolidated Standards of Reporting Trials diagram of study participation is presented in Supplemental Figure S1. One participant in the positive condition withdrew shortly after the baseline session

due to time constraints and had to be excluded as they completed too few AM entries (as per preregistered exclusion criteria). This resulted in a final sample size of 60.

## Sample Size Estimation

The sample size and the number of training tasks were determined by an a priori power analysis for the primary hypothesis, notably the cross-level interaction between experimental conditions (Level 2: positive vs. everyday activity) and intraindividual change across time in feelings of happiness (Level 1: pre–post AM recollection), with AM assessments being nested within participants. Following state-of-the-art recommendations for power analysis in ecological momentary assessment studies (Arend & Schäfer, 2019; Trull & Ebner-Priemer, 2020), we conducted a simulation-based power analysis using the "simr" package (Green & MacLeod, 2016) in R for a two-level model, estimating (based on Grol et al., 2017) a large cross-level interaction effect (standardized estimate: .50; i.e., individuals in the positive condition experience a stronger increase in feelings of happiness from pre- to post-AM recollection). We anticipated (per Arend & Schäfer, 2019) a moderate intraclass correlation coefficient of 0.50 (as Level 1 units are repeated measures), and in the absence of an informed estimate of the random slope, we assumed a medium random slope variance (standardized estimate = .09) and correlation of 0.00 between random intercept and random slope, allowing a conservative power estimation for cross-level interaction effects (Arend & Schäfer, 2019; Martin et al., 2011).

The resulting power analysis with 10,000 simulations yielded a sample size of 60 participants with 14 AM assessments on Level 1 to be sufficient to achieve 85.51% power (confidence interval: 84.80%; 86.90%) with a two-tailed α of .05. This resulted in a target sample size of 60 participants (30 per condition).

### *Positive and Everyday Activity AM Condition*

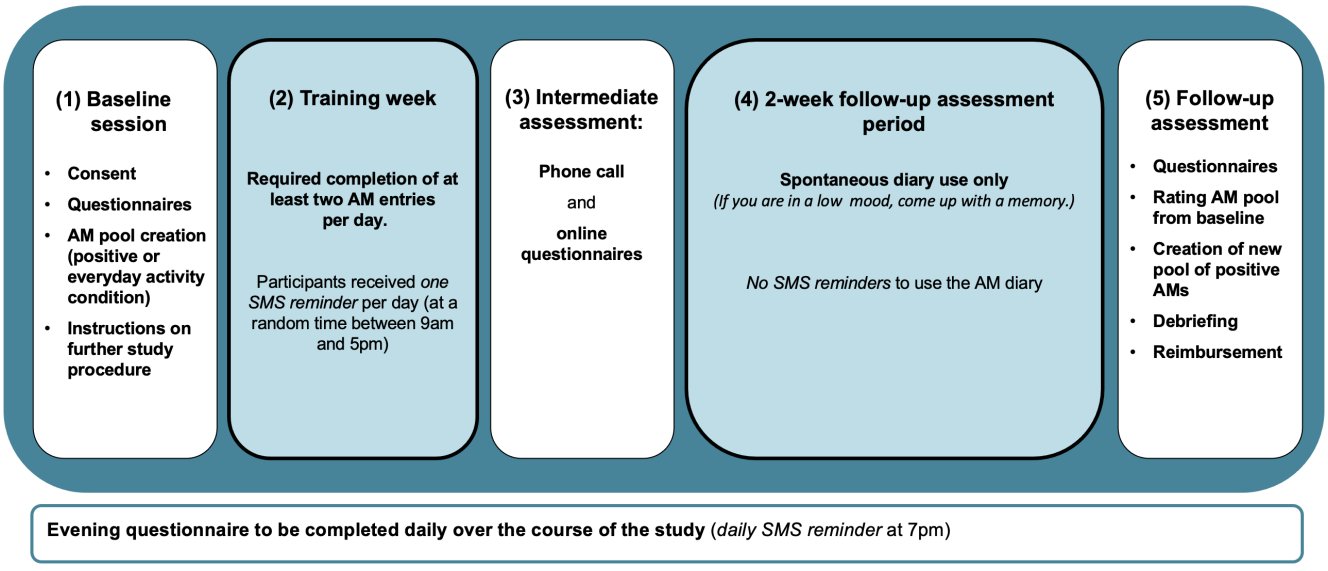
Study participants were randomly allocated to either the positive or everyday activity AM condition. Those in the positive AM condition were instructed to compile a pool of six specific positive AMs that made them feel happy or satisfied when thinking about them and that reiterated a positive sense of self that could be later used to improve low mood. Participants in the everyday activity AM diary condition were instructed to select a pool of six relatively everyday activity AMs that were not emotional in meaning (i.e., participants should not experience strong negative or positive emotions upon retrieval). To encourage more natural use, participants were free to choose whichever of the six AMs they felt would help them most in a given situation. Regarding the size of the AM pool, our group has conducted two previous studies in which participants were trained to use their positive AMs to counteract low mood using mnemonic techniques (Dalgleish et al., 2013; Werner-Seidler & Dalgleish, 2016). In these two studies, participants created a pool of 15 positive AMs. However, our experience from these studies suggested that a smaller pool of the strongest positive AMs would be optimal. Six AMs provided variability while still being easy to select on a smartphone screen.

## Study Procedures

Study procedures were preregistered (https://osf.io/n36cu). The study comprised a 3-week assessment period: one training week and a 2-week follow-up period. Each participant completed (1) baseline session, (2) training week, (3) intermediate assessment, (4) 2-week

**Figure 1**

*Study Procedure: The Study Consisted of a 3-Week Assessment Period Consisting of a Training Week and a 2-Week Follow-Up Period*




*Note.* Specifically, (1) the baseline assessment was followed by (2) the training week, (3) the intermediate assessment, (4) the 2-week follow-up period, and (5) the follow-up assessment; AM = autobiographical memory; SMS = short message service. See the online article for the color version of this figure.

follow-up assessment period, and (5) final 30-min follow-up session. A visualization of the study procedure is provided in Figure 1. Data were collected January–November 2020. Although baseline and the 2-week follow-up sessions were initially conducted face-to-face, all study appointments from mid-March 2020 were conducted via phone and online due to restrictions related to the COVID-19 pandemic. Questionnaires, consent-taking, and the memory recollection tasks were all completed in REDCap (Harris et al., 2009, 2019). Twelve participants completed the baseline session on-site (20%), and 48 people completed it online (80%). The final follow-up session was attended by 10 people on-site (16.67%) and 50 people online (83.33%).

### Baseline Session

Following informed consent, participants provided information on age, gender, education history, and use of medications that may impact affect (e.g., antidepressants, lithium) and completed self-report questionnaires assessing residual depressive symptoms, mental well-being, mental imagery, and emotion regulation abilities. They were then guided by a researcher to compile their AM pool. The instructions for compiling the positive and the everyday activity AM pool are provided in Supplemental Material (S2). Afterward, participants received a detailed introduction to the use of the memory recollection technique and the online diary, which recorded their recollected memories and was accessible via a link on the home screen of their personal smartphone. Participants were also guided to complete one End-of-Day Questionnaire (see Measures section).

### Training Week

Over the first week, participants were instructed to complete a memory task twice a day, which they recorded in the memory diary. They were also instructed to use the memory technique (documenting this in the diary) whenever they felt that their mood was low or dropping. Participants deliberately retrieved one of the six memories from the pool created during the initial session (a detailed overview of the AM diary is provided in Supplemental Figures S3 and S4). Participants rated their emotional experience pre- and post-AM recollection and how vivid and imagery-rich the recollected memory was. Participants in both AM conditions were instructed: "Try to build up a detailed image of the event, as if a movie of the event was unfolding in your head. Spend a few moments imagining the event as if you were really there in the situation." Individuals in the positive AM condition received the following additional instruction: "Focus on the positive emotions that are linked to the memory and try to feel them now." Participants were also able to use the memory task unprompted at any time they noticed their mood deteriorating. Participants received two text messages per day: one at 3 p.m. (reminder to complete memory task) and one at 7 p.m. (reminder to complete End-of-Day Questionnaire). If participants did not complete any AMs on a given day, we would call them the next day to check that they understood the study procedure or if they had any technical problems. If participants completed only one AM entry on a given day, we would wait to see if this pattern repeated a second time so as not to overwhelm participants. We would then call participants if they had 2 days with only one AM completed to see if anything was unclear or if they had any technical difficulties. In addition, if participants missed more than two evening questionnaires within a short period of time, we would call them to see if they had any technical problems or questions about the study design.

### Intermediate Assessment

Following the training week, participants received a brief phone call to inform them that the daily reminders to complete the memory task would no longer happen (the evening reminders did continue) and that they were to continue using the memory technique (and documenting this in the diary) whenever they experienced a downturn in mood over the next 2 weeks. They were also emailed online questionnaires indexing residual depressive symptoms and mental well-being and asked to complete the questionnaires that day. If participants were not available on the phone on the day of the intermediate assessment, we would try to call them in the following week and also send them an email reminding them that the assessment period had changed from the training week to the 2-week follow-up period.

### Two-Week Follow-Up Period

For 2 weeks, participants were asked to use the memory technique, with recollection to be aided by and recorded in the diary at any time they perceived a downturn in mood. Participants continued to complete the End-of-Day Questionnaire until the end of the study. They received a daily short message service reminder at 7 p.m.

### Follow-Up Assessment

At the end of the 2 weeks, participants again completed the questionnaires on residual depressive symptoms, mental well-being, and the vividness of visual imagery. Further, participants rerated the six memories from their original memory pool and generated and rated a new set of six positive memories. Finally, participants were debriefed and reimbursed. If participants could not be contacted for the follow-up assessment, we would try to call them in the following 2 weeks and also contact them by email.

### Measures

Measures from the present study that were included in the analyses are detailed in the following section.

Collected measures not included in the analyses are provided in Supplemental Material (S5).

## Memory Recollection and Recording

The digital AM diary started with a welcome screen, and participants were asked to indicate whether they were making an entry for training purposes or a spontaneous entry in response to a low mood. They then indicated on a visual analog scale from 1 to 100 (*not at all*; *extremely*) the degree to which they felt four positively (i.e., happy, interested, surprised, proud) and four negatively (i.e., scared, sad, upset, guilty) valenced affect terms. Their six preselected AMs were then displayed, participants chose a memory to recall, and they were subsequently presented with recollection instructions. Both the positive and everyday activity conditions were instructed to recollect their AM in a vivid and imagery-rich way, but only in the positive condition were participants asked to focus on their positive

emotions the memory elicited. Upon recollection of the memory, participants worked through a series of prompts (see Supplemental Figures S3 and S4) that guided them to experience their AMs in a vivid (and, in the case of a positive AM, emotional) fashion. This took approximately 3 min to complete, following which participants rated AM vividness and AM-related imagery. Participants rated positive AM vividness on a 5-point Likert scale (*strongly disagree* to *strongly agree*) for three noninverse items taken from the Memory Experiences Questionnaire (Sutin & Robins, 2007; *my memory of the event is very vivid*; *my memory of the event is very detailed; my memory is very clear.*) AM-related imagery was measured through four items capturing different senses (i.e., *see the memory with your mind's eye?/hear the memory with your mind's ear?/smell fragrances/feel physical sensations?*; Slofstra et al., 2017), with participants responding on a visual analog scale from 1 (*not at all*) to 5 (*completely*). Afterward, participants rerated their experience of each of the positive and negative emotions. The whole task took approximately 5 min.

### End-of-Day Questionnaire

Affect was assessed every evening with an adapted short form of the Positive and Negative Affect Schedule (Thompson, 2007), worded to assess average affect retrospectively over the course of the day (for more details, see Supplemental Material S5). Participants were then asked if they thought of any of the six AMs at times when they were not keeping the diary. If they answered in the affirmative, they were asked how often this was the case and whether they thought of them deliberately or if they appeared out of nowhere. If the participants thought of any of the AMs deliberately, they were also asked if this was due to a low mood and, if so, how often this was the case. A detailed overview on the End-of-Day Questionnaire is provided in Supplemental Figure S6. Participants were asked to complete the questionnaire at 7 p.m. Any entries completed between 6 p.m. and 1 a.m. were included, and any evening questionnaires that had been suspended for longer than 15 min were excluded.

### Beck Depression Inventory–II (Beck et al., 1996)

The Beck Depression Inventory–II (BDI-II) is a 21-item self-report measure assessing depressive symptoms over the previous 2 weeks. For each item, participants need to choose the statement that best describes how they feel (e.g., "0 I do not feel sad; 1 I feel sad; 2 I am sad all the time and I can't snap out of it; 3 I am so sad and unhappy that I can't stand it"). Cronbach's internal consistency was high, $\alpha = 0.90$ (95% CI [0.87, 0.94]).

### The Short Warwick–Edinburgh Mental Well-Being Scale (Tennant et al., 2007)

This self-report measure uses positively worded items to capture different facets of positive mental health (e.g., "I've been feeling optimistic about the future"; "I've been feeling useful"), which are rated on a 5-point Likert scale (i.e., *none of the time*; *rarely*; *some of the time*; *often*; *all of the time*). Again, Cronbach's internal consistency was high, $\alpha = 0.83$ (95% CI [0.77, 0.9]).

### *Analytic Approach*

All analyses were preregistered and conducted in R, Version 4.1.0 (R Core Team, 2022), using RStudio, Version 2022.02.3 (RStudio Team, 2022). Group comparisons for descriptive statistics were made using $\chi^2$ tests and independent samples $t$ tests for interval-scaled variables. Differences between observed frequencies were calculated using the $\chi^2$ goodness of fit test.

To evaluate the primary hypothesis, we predicted feelings of happiness and sadness during the training week by time (Level 1: pre- vs. post-AM recollection), condition (Level 2: positive self-affirming vs. everyday activity condition), and their interaction term using linear mixed models. Time elapsed between the AM entries was modeled in days that had passed since the baseline session. We included a random intercept for days nested in participants and a random slope for the time elapsed between the AM entries (in days) in models to examine whether effects increased over the course of the study. We also corrected for nonindependence of the time series data by modeling a first-order autoregressive structure. This structure accounts for the varying temporal distances between the observations, which are nested within individuals across days. All models were computed with nlme package, Version 3.1-162 (Pinheiro et al., 2023). Tables were created using sjPlot, Version 2.8.10 (Lüdecke, 2018).

Our second hypothesis concerned the generalization of any benefits from the recollection of positive AMs to untrained memories. Specifically, we predicted AM valence, happiness/satisfaction upon recall, AM vividness, and self-concordance by condition (positive vs. everyday activity) using multivariate linear regression with the "manova" function from the "stats" package (R Core Team, 2022). The number of AM entries across the 3-week period was a covariate.

Deviating from our preregistration, to evaluate feasibility, we predicted the number of spontaneous AM entries in the 2-week assessment period, per person by condition (positive vs. everyday activity), using a Poisson model, which is better suited for highly skewed count data than the linear regression models we intended to use. We further considered the average emotional benefit in feelings of happiness and sadness (i.e., the mean difference between the feelings of happiness and sadness, respectively, pre- and post-AM recollection) as moderators of the effect of condition. For moderation analysis, we probed simple effects using the "emmeans" R package.

Using the R packages "lme4" and "lmerTest," we examined in two separate linear mixed effects models potential change in BDI-II and Short Warwick–Edinburgh Mental Well-Being Scale over the course of the study. We predicted the sum score by condition (positive, everyday activity), time (baseline, end of training week, 2-week follow-up), and their interaction term using linear mixed effects models with a random intercept for participants.

**Openness and Transparency.** This study's predictions and analysis strategy are preregistered (https://osf.io/n36cu; Haag et al., 2023). Study materials are provided in Supplemental Material. The data and code to reproduce the analyses are also available as Supplemental Materials.

## Results

### Sample and Training Characteristics

For the 60 included individuals (75% female), the mean age was 43.73 years ($SD$ = 13.89 years; range = 21–68 years). Baseline

descriptive statistics are presented in Supplemental Table S7. Participants in the two conditions (positive, everyday activity) did not differ significantly on clinical characteristics or mental imagery on the Vividness of Visual Imagery Questionnaire ($ps \geq .08$), but in terms of education ($p = .03$). Twelve participants (20%) had received psychological treatment and 29 (33.33%) psychopharmacological treatment at baseline. At baseline, the six training memories provided by the positive AM condition were higher in positive emotional valence, $p < .001$, and evoked greater happiness, $p < .001$, than the everyday AM condition. There was no difference between groups in the vividness of memories, $p = .36$ (see Supplemental Table S7).

Participants in the positive condition provided an average of 12.00 per individual (range = 6–15) during the training week. In terms of AM selection, they used between four and six of their diary AMs during this time (mean: 5.43). Participants tended to use their six AMs with equal frequency ($\chi^2 = 4.45$, $df = 5$, $p = .487$). During the 2-week follow-up period, participants of the positive condition averaged 4.81 entries per individual (range = 1–23). Participants' use of their six AMs ranged from one to six (mean: 3.19) during this time, and they tended to use only a subset of their six AMs rather than using all of them with equal frequency ($\chi^2 = 30.13$, $df = 5$, $p < .001$). Participants in the everyday activity condition provided an average of 11.63 AM entries per individual (range = 5–16) in the training week. During the training week, their use of AMs ranged from one to six (mean: 5.43), but overall they tended to use all six AMs equally ($\chi^2 = 2.61$, $df = 5$, $p = .76$). During the 2-week follow-up period, participants in the everyday activity condition provided an average of 4.00 AM entries per individual (range = 1–12).and/or appreciated by loved ones ($n = 29$; 16.11%), vacation ($n = 23$; 12.78%), and personal successes ($n = 19$; 10.55%). Everyday activity AMs mainly involved shopping/running errands ($n = 27$; 15.00%), logistical activities ($n = 24$; 13.33%), work around the house ($n = 20$; 11.11%), and cleaning/tidying up ($n = 18$; 10.00%). The full list of AM categories for the positive and the everyday activity condition, together with examples of AM descriptions, is provided in Supplemental Material (S8 and S9). Baseline questionnaires of two individuals completed in person in the days immediately prior to the first U.K.-wide COVID-19 lockdown were lost. Paper-based, baseline AM ratings from other individuals assessed prior to the first COVID-19 lockdown ($n = 10$) were also lost.

In terms of compliance, 90.00% of participants in the positive condition and 86.67% in the everyday activity condition completed 60% or more of the intended 14 AM diary assessments during the training week. Similarly, for the evening questionnaires, 96.70% of the positive condition and 93.30% of the everyday activity condition met or exceeded 60% completion of scheduled assessments.

## Change in Feelings of Happiness and Sadness (Primary Hypothesis)

Confirming our preregistered hypothesis, participants in the positive condition experienced a greater intraindividual increase in feelings of happiness from pre- to post-AM recollection during the training week compared to individuals in the everyday activity condition (Table 1 and Figure 2). Also confirming our preregistered hypothesis, participants in the positive condition experienced a greater

**Table 1**

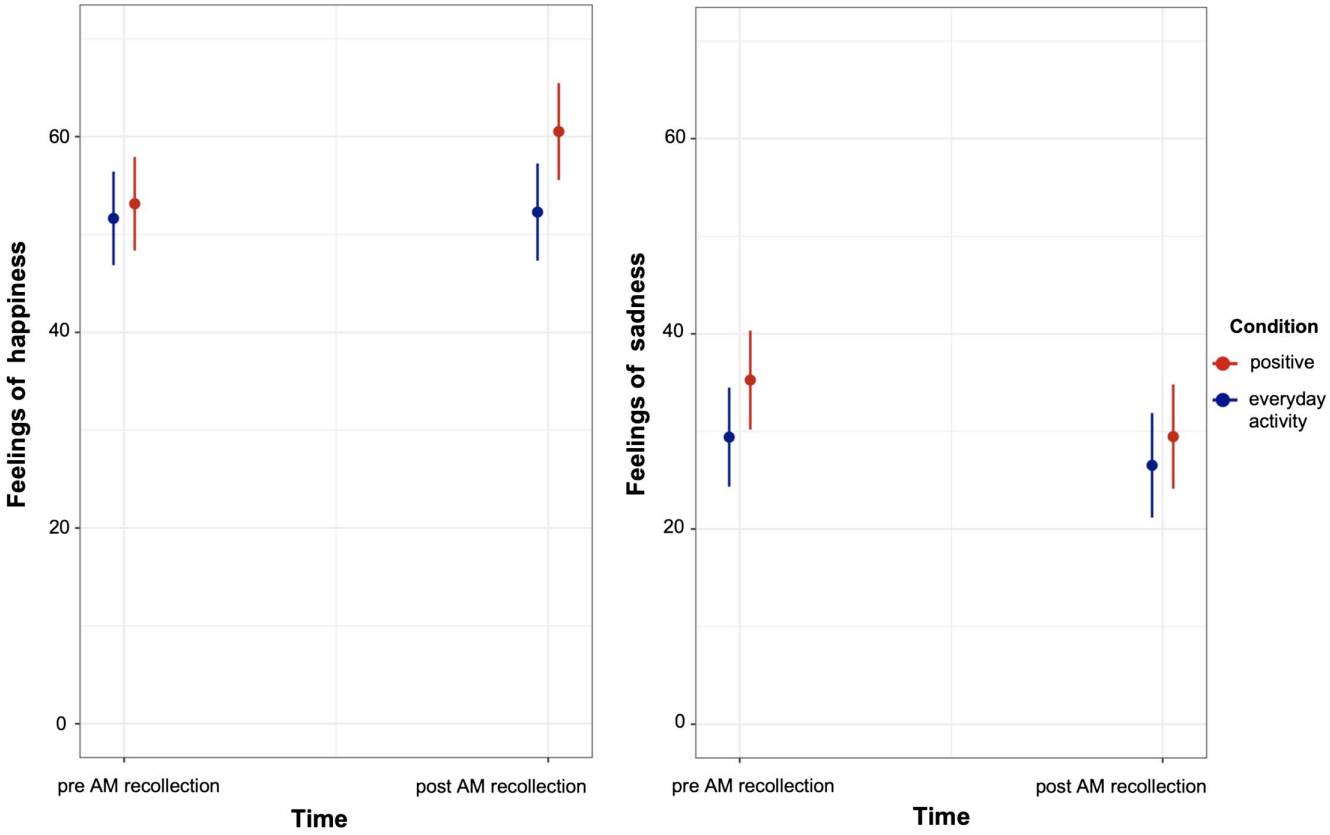
*Random Intercept Model Regressing Feelings of Happiness and Sadness on Time (Pre- Vs. Post-AM Recollection), Condition (Positive, Everyday Activity), and Time Elapsed Since Baseline*

| Predictor | Feelings of happiness | | | Feelings of sadness | | |
|---|---|---|---|---|---|---|
| | *b* | 95% CI | *p* | *b* | 95% CI | *p* |
| Intercept | 51.41 | [45.86, 56.95] | **<.001** | 33.73 | [27.72, 39.73] | **<.001** |
| Condition (positive) | 1.50 | [−5.35, 8.35] | .663 | 5.84 | [−1.33, 13.02] | .108 |
| Time (post-AM recollection) | 0.65 | [−0.69, 1.98] | .343 | −2.89 | [−4.57, −1.20] | **.001** |
| Time elapsed since baseline (in days) | 0.06 | [−0.83, 0.95] | .897 | −1.08 | [−2.21, 0.05] | .061 |
| Time (post-AM Recollection) × Condition (positive) | 6.73 | [4.85, 8.62] | **<.001** | −2.90 | [−5.27, −0.52] | **.017** |
| Random effects | | | | | | |
| $\sigma^2$ | 200.75 | | | 319.01 | | |
| $\tau_{00}$ | 11.38 $_{\text{day}}$ | | | 12.56 $_{\text{day}}$ | | |
| | 11.74 $_{\text{individual}}$ | | | 7.25 $_{\text{individual}}$ | | |
| $\tau_{11}$ | 1.99 $_{\text{day, time since baseline (in days)}}$ | | | 2.94 $_{\text{day, time since baseline (in days)}}$ | | |
| | 0.99 $_{\text{individual, time since baseline (in days)}}$ | | | 0.29 $_{\text{individual, time since baseline (in days)}}$ | | |
| $\rho_{01}$ | −0.26 $_{\text{day}}$ | | | −0.45 $_{\text{day}}$ | | |
| | −0.87 $_{\text{individual}}$ | | | −0.09 $_{\text{individual}}$ | | |
| ICC | 0.20 | | | 0.16 | | |
| *N* | 8 $_{\text{days}}$ | | | 8 $_{\text{days}}$ | | |
| | 60 $_{\text{individuals}}$ | | | 60 $_{\text{individuals}}$ | | |
| Observations | 1,418 | | | 1,418 | | |
| Marginal $R^2$/conditional $R^2$ | 0.049/0.237 | | | 0.037/0.193 | | |

*Note.* Bold formatting of *p*-values denotes statistical significance. AM = autobiographical memory; $\sigma^2$ = within-person residual variance; 95% CI = 95% confidence interval; $\tau_{00}$ = random intercept variance in feelings of happiness and sadness across individuals while taking into account the within-day nested structure.; $\tau_{11}$ = random slope variance within-person fluctuations in feelings of happiness/sadness over the course of the successive AM diary entries at two levels of nesting (individual, day); $\rho_{01}$ = relationship between random intercept and random slope at two levels of nesting (individual, day); ICC = intraclass correlation coefficient (variance attributable to between-person variability in AM-related feelings of happiness); *N* = sample size; marginal $R^2$ = variance explained by fixed effects only; conditional $R^2$ = variance explained by fixed and random effects.

**Figure 2**

*Feelings of Happiness and Sadness From Pre- to Post-AM Recollection for the Positive and Everyday Activity Condition*




*Note.* *Left panel:*Interaction plot of feelings of happiness (*y*-axis) and time (*x*-axis; pre- vs. post-AM recollection) for the positive condition (red) and the everyday activity condition (blue). *Right panel:* Interaction plot of feelings of sadness (*y*-axis) and time (*x*-axis; pre- vs. post-AM recollection) for the positive AM condition (red) and the everyday activity AM condition (blue). Feelings of happiness and sadness were assessed on a visual analog scale from 0 to 100; AM = autobiographical memory. See the online article for the color version of this figure.

intraindividual decrease in feelings of sadness from pre- to post-AM recollection during the training week compared to individuals in the everyday activity condition (Table 1 and Figure 2). For both feelings of happiness and sadness, there was no effect of time elapsed (in days) during training. Individual-level plots for feelings of happiness and sadness are shown in Supplemental Figures S10 and S11.

To explore whether the pandemic impacted our analyses, we included a binary pandemic covariate (i.e., assessment before/after the first U.K.-wide lockdown) in all analyses. This predictor was nonsignificant for both feelings of happiness and feelings of sadness, *p*s ≥ .704. There was no interaction between condition and pandemic, *p*s ≥ .053. Twelve participants were enrolled before the U.K.-wide COVID-19 lockdown in March 2020, and all other participants ($n = 48$) were enrolled afterward.

## Impact on Untrained Memories (Second Hypothesis)

The new, untrained positive self-affirming AMs retrieved during the final assessment did not differ between the positive and everyday activity condition, Pillai = 0.03, approximate $F = 0.43$, $df = (4,51)$, $p = .783$, in terms of emotional valence, happiness, or satisfaction at retrieval, vividness, and more self-concordance (see Supplemental Figure S12). We also controlled for the amount of training with the diary (i.e., overall number of times that individuals completed the diary during the training week) and found that it had no significant effect, Pillai = 0.07, approximate $F = 0.99$, $df = (4,50)$, $p = .423$.

## Potential of the Training Technique (Third Hypothesis and Exploratory Research Question)

One individual in the positive condition had an exceptionally high spontaneous use of the AM technique during the 2-week follow-up period (48 times) and was excluded from the analysis for this reason. The remaining participants in the positive condition used the AM diary technique on average 5.86 times spontaneously during the 2-week follow-up ($SD = 6.74$; range = 0–26). Participants in the everyday activity condition used the AM diary technique on average 4.13 times during the 2-week follow-up ($SD = 6.19$, range = 0–18).

Poisson regression showed that individuals in the positive condition spontaneously used the AM technique more often during the 2-week follow-up period ($p < .001$, Table 2). This effect of

**Table 2**

*Poisson Regression Model Predicting Spontaneous AM Diary Use During the 2-Week Follow-Up Period by Condition (Positive, Everyday Activity) and Emotional Benefit During the Training Week (Increase in Feelings of Happiness, Decrease in Feelings of Sadness)*

| | Spontaneous AM diary use during the 2-week follow-up period | | |
|---|---|---|---|
| Predictor | Incidence rate ratio | 95% CI | *p* |
| Intercept | 2.62 | [2.01, 3.35] | **<.001** |
| Condition (positive) | 1.83 | [1.31, 2.58] | **<.001** |
| Change in feelings of happiness | 0.99 | [0.97, 1.01] | .414 |
| Change in feelings of sadness | 0.87 | [0.84, 0.91] | **<.001** |
| Condition (Positive) × Change in Feelings of Sadness | 1.11 | [1.06, 1.15] | **<.001** |
| Observations | 59 | | |
| $R^2$ Nagelkerke | 0.653 | | |

*Note*. Bold formatting of *p*-values denotes statistical significance. 95% CI = 95% confidence interval; AM = autobiographical memory.



condition was moderated by the degree of change in feelings of sadness from pre- to post-AM recollection during the training week ($p < .001$). We probed simple slopes for the association between change in feelings of sadness and spontaneous use of the AM diary technique during the 2-week follow-up for the two conditions separately. Pairwise comparison indicated that the slopes differed between the two conditions by 0.1 units, contrast positive/everyday activity condition: $b = -0.1$, $SE = 0.02$, $df =$ Inf (asymptotic test), $z$-ratio $= -4.58$, $p < .001$. In the everyday activity condition, change in feelings of sadness and spontaneous use of the AM diary technique were negatively associated, $b = -0.13$, $SE = 0.02$, $df =$ Inf (asymptotic test), asymptotic 95% CI [−0.17, −0.10]. Specifically, a one-unit decrease in sadness was associated with a 10.09% increase in spontaneous recall of their AMs during the 2-week follow-up. The positive condition also showed a negative association between feelings of sadness and spontaneous use of the AM diary technique, $b = -0.03$, $SE = -0.01$, $df =$ Inf (asymptotic test), asymptotic 95% CI [−0.06, −0.01]. For a one-unit decrease in sadness, the expected spontaneous use of the AM diary technique increases by about 3.37% in the positive condition. A visualization of the simple effects analysis is presented in Supplemental Material (S13). Finally, we also included a binary pandemic covariate (assessment before/after the first U.K.-wide lockdown) in the analysis and found no main effect of the pandemic ($p = .103$), so it was not included in the final model.

In an exploratory analysis, we were interested in whether training may increase spontaneous recall of positive AMs during the 2-week follow-up period, at times when participants were not completing their diary. This information was assessed through the daily evening questionnaire. We found that participants in the positive condition were more likely to think about their positive AMs unprompted throughout the day, $p < .001$. We also found that participants were more likely to spontaneously remember their AMs before the first U.K.-wide lockdown, $p < .001$ (see Figure 3 and Supplemental Table S14). There was no interaction between condition and pandemic, $p = .308$.

In terms of residual depressive symptoms, there was a statistically significant decrease at 2-week follow-up in BDI-II sum scores in both conditions, $p = .049$, but no interaction between condition and time, $ps \geq .061$. Regarding well-being as assessed by the Short Warwick–Edinburgh Mental Well-Being Scale, there was no change over time (baseline, end of training week, 2-week follow-up), no effect of condition, and no interaction between condition and time, $ps \geq .107$. This means that there was a decrease in residual depressive symptoms at 2-week follow-up, independent of the condition. Detailed results are provided in Supplemental Table S15. To explore whether the pandemic affected our analysis, we included a binary pandemic covariate into the analyses (assessment before/after the first U.K.-wide lockdown), which was nonsignificant, $ps \geq .164$. There was also no interaction between pandemic and condition, $ps \geq .860$.

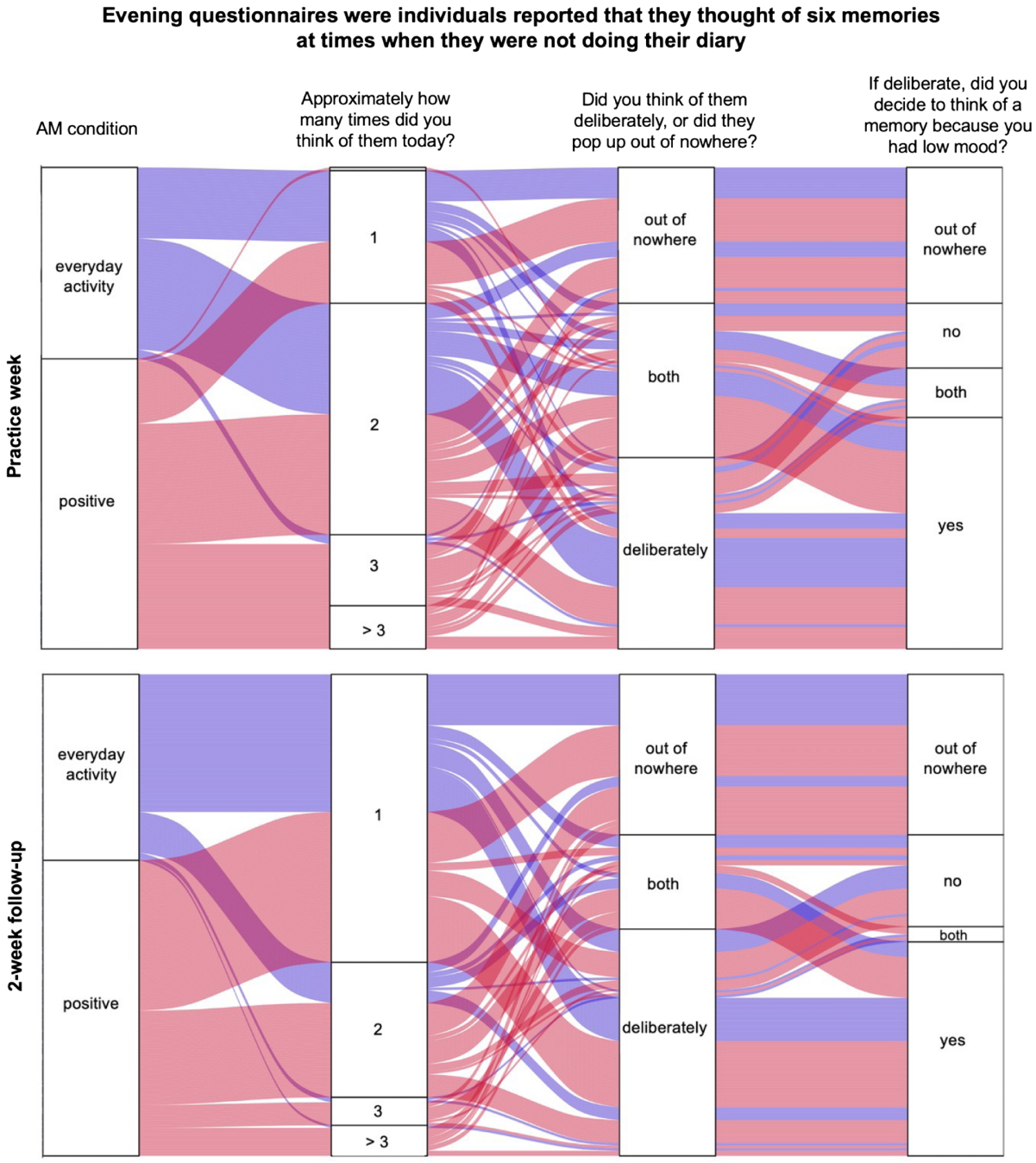
## Discussion

The present study investigated whether individuals with current major depressive disorder, but in remission, would experience emotional benefit from and, as a result, spontaneously use detailed recollection of positive self-affirming AMs to counteract low or dipping mood in their daily life. In line with our first pre-registered hypothesis, individuals in a condition trained in detailed recollection of positive AMs experienced a greater intraindividual decrease in feelings of happiness and feelings of sadness from pre- to post-AM recollection compared to a control condition trained with everyday activity AMs. While participants in the positive condition used the AM diary technique more frequently overall during the 2-week follow-up, the effect of condition was moderated by change in feelings of sadness. A greater decrease in feelings of sadness during training was associated with more frequent use of the AM diary technique during follow-up. Notably, the negative association between sadness and the use of the diary technique was stronger in the everyday activity condition. We found no difference between the training conditions for the emotional vividness of untrained positive AMs collected in the final assessment, nor in residual depressive symptoms or mental well-being over the course of the study.

In line with our predictions, participants in the positive AM condition experienced greater intraindividual increases in feelings of happiness and greater decreases in feelings of sadness from pre- to post-AM recollection compared to individuals in the everyday activity condition. This is consistent with prior laboratory-based research and assertions that recollection of positive, self-affirming AMs in everyday life is associated with greater well-being (Werner-Seidler & Dalgleish, 2016; Werner-Seidler et al., 2017). Demonstrating this

**Figure 3**

*Daily-Life Memory Recollection Without Diary Completion*




*Note.* Diagram displaying how often, and with what intention, or without any intention, subjects in the positive (red) and everyday activity (blue) condition remembered their memories on days when they indicated in the evening that they had remembered them but had not filled in the diary. See the online article for the color version of this figure.

effect outside of the laboratory for recollection among an individual's daily activities has important implications for the use of memory recollection as a technique to regulate transient negative emotion—a key predictor of depressive relapse (Teasdale, 1988).

This effect on feelings of happiness did not strengthen over repeated recollections across the training week. This indicates that consistent training in positive AM recollection will not increase the emotional benefits and has important implications for further

development of memory-based interventions. Most specifically, detailed instructions for vivid memory recollection delivered in a single session may be sufficient to provide a tool that remitted individuals can use in everyday mood regulation, but consistent, positive memory training in this manner is unlikely to increase effects. Our results do suggest that smartphone-facilitated recollection of positive AMs may be a simple to learn, quick, and easily accessible tool that can be easily disseminated to enhance positive affect in everyday life. Indeed, the fact that those in the positive AM condition engaged more frequently in spontaneous use of the memory diary suggests that remitted individuals *perceived* AM recollection as a helpful strategy. Our results indicate a relationship between a decrease in feelings of sadness during training and increased use of the diary technique. Conversely, an increase in sadness correlated with decreased use of the AM technique. This more pronounced effect in the everyday activity condition could be overly influenced by the limited number of people who experienced a pronounced decrease in sadness. This difference between conditions could also be due to everyday activity AMs being less pleasurable to recall, so that only those who really benefited from recalling them might continue to do so. In addition, the extent to which participants used the AM diary technique in their daily lives varied considerably, suggesting the influence of various external factors. Given this heterogeneity and the relatively small effects, especially in the positive condition, it is important to interpret our findings with caution. However, our findings on diary use support the notion that those who benefit more tend to use the diary more. They also suggest that asking participants to reflect on any perceived benefits from the first few uses of a technique may encourage better use of the technique in everyday life. Our findings may therefore help guide the real-world dissemination of positive memory recollection techniques.

Contrary to our predictions, we found no transfer effects to depressive symptoms or recollection of untrained positive memories. Individuals of both conditions produced a new pool of AMs in the follow-up assessment that was equally positive, vivid, self-concordant, and evoked feelings of happiness/satisfaction during recollection. This may have been impacted by the methods we used. We did not measure ease of access, for example, using recall latencies, which have been previously shown to be an aspect of positive AM recollection that is complicated by the experience of depression (Hitchcock et al., 2020) and can influence the strength of negative self-cognitions, which predict depressive relapse (Hitchcock et al., 2017).

Indeed, the accessibility of AMs is related to their emotional intensity (Holland & Kensinger, 2010). Assessment of physiological markers of AM characteristics (e.g., pupil dilatometry to index imagery vividness; Kay et al., 2022) would also reduce the reliance on metacognitive measures of memory evident in our study. Furthermore, in remitted samples, enhancing regulation of transient mood is aimed at reducing relapse risk rather than treating residual depressive symptoms. However, the short time frame of our study did not allow evaluation of relapse, thus we are unable to draw conclusions regarding the efficacy of our training technique as a relapse-prevention intervention. Future research with a longer timeframe would be needed to determine whether counteracting transient negative emotions by recollecting positive AMs provides a skill that prevents or shortens depressive relapse. Future research would also benefit from investigating everyday activities or "neutral" AMs that are similar to positive AMs in terms of their temporal distance from the present. A key challenge will be to identify specific AMs that evoke little or no emotion and can still be remembered in detail despite the time that has elapsed since their occurrence.

Over the 2-week follow-up period, study participants tended to favor some of their six AMs or a subset of them. This suggests that some AMs may be particularly appropriate at times when people are feeling low, while other AMs may not be as effective at times of low mood. Future studies might also consider encouraging participants to continually update their personal pool of AMs with new AMs to ensure that participants always have an up-to-date pool of positive AMs to draw on at times when they are feeling low. Participants' brief descriptions of their AMs suggest that many of the positive AMs involved other people or pets to whom individuals felt connected. Further investigation prompting of retrieval of social versus nonsocial positive AMs may help to clarify whether larger benefits for mood are driven by retrieval of positive social memories rather than positive memories per se. Finally, we aimed to increase positive memory retrieval in a sample experiencing deteriorated positive memories. However, establishing a habit of using positive AM recollection for emotion regulation purposes could also be useful for unselected community samples. Harnessing the power of smartphones to support regulation of everyday distress and low mood could be a scalable approach to supporting positive mental health in the general population.

Compliance with daily-life AM entries during the training week was low for a number of participants in both conditions. When contacted by telephone following missed daily-life assessments, participants often cited difficulty or inability to take flexible breaks during working hours as a reason for not completing AM entries. With regard to the evening questionnaire, participants often cited that if they did not complete the questionnaire soon after the text message reminder, they sometimes tended to forget later due to work or home/care commitments. One way to avoid such compliance problems in the future and still involve people with busy lives might be to opt for a less intensive and flexible ecological momentary assessment design. For example, only one training AM entry per day over a longer period of time and possibly removing the evening questionnaire to reduce the burden on participants in their daily lives.

Our study has several limitations that merit consideration. First, the present study's sample comprised predominantly White British adults who were mostly well-educated. Therefore, it is not clear whether our findings can be fully generalized to adults with remitted depression from other backgrounds. Second, our study was conducted in 2020, immediately before and during the COVID-19 pandemic. To explore whether the pandemic impacted our analyses, we included a binary pandemic covariate (i.e., assessment before/after the first U.K.-wide lockdown) in all analyses and found no evidence that this was the case. However, we did not have adequate power to comprehensively evaluate the impact of lockdowns on diary use, but we do note that the presence of the pandemic and associated stress may have impacted results. Finally, there is of course the potential that demand effects impacting the improvement in affect, but the greater increase in the active relative to control intervention suggests that demand effects are unable to solely account for results.

The most effective way to embed positive AM recollection into daily life now needs to be considered. The smartphone guided recollection worked well here; however, individuals might even

benefit from more subtle reminders (e.g., photos/pictures on their smartphone lock screen or a memento) that fit well into daily life and that have been previously associated with positive, self-affirming AMs. Associations between increased recollection of positive AMs and relapse-reducing factors such as the strength of positive self-beliefs, perceived self-efficacy, and anhedonia may also warrant investigation. Systematically uncovering and strengthening the positive, self-affirming AMs of people with a history of depression may increase the daily experience of positive affect and potentially promote their recovery.

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