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Was I happy today? The influence of positive emotion regulation and depressive symptoms on recalled happiness.

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HAL Authorization

1 **WAS I HAPPY TODAY? THE INFLUENCE OF POSITIVE EMOTION**
2 **REGULATION AND DEPRESSIVE SYMPTOMS ON RECALLED HAPPINESS**

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Abstract

21 Depression is often associated with positive affect recall bias - recalling pleasant affective
22 experiences as less positive than they were. Research suggests this bias may arise from
23 maladaptive emotion regulation patterns, including reduced daily use of strategies that amplify
24 positive emotions and increased reliance on those that dampen them. This study examined the
25 relationship between daily experienced happiness, positive emotion regulation and recalled
26 happiness over a 10-day period in 155 participants with varying levels of depressive symptoms.
27 Daily recalled happiness was significantly predicted by higher use of amplifying and lower
28 dampening strategies. Individuals with more severe depressive symptoms recalled less
29 happiness, even on relatively happy days. In this group, increase in daily use of amplifying
30 strategies was associated with greater recalled happiness, whereas their decrease led to
31 significantly diminished recalled happiness. Overall, boosting positive emotion regulation may
32 improve how individuals with higher depressive symptoms recall their pleasant affective
33 experiences.

34 **Keywords:** positive emotion regulation, affect recall bias, depression, amplifying, dampening

35

General audience summary

36 Depression is often associated with the tendency to recall positive experiences as less positive
37 than they were (namely, *positive affect recall bias*). Research shows that the strategies we use to
38 modify ongoing emotions can significantly influence how we remember emotional moments.
39 Accordingly, using strategies that amplify and upregulate positive emotions has been shown to
40 promote more vivid and positively-valenced memories. Though, individuals with depression
41 tend to rely less on these strategies, instead using strategies that dampen positive emotional
42 states. This maladaptive pattern in regulating positive emotions may contribute to the positive
43 affect recall biases observed in this population.

44 In this study, we gathered data from 155 participants with varying depression levels through a
45 mobile app, focusing on daily happiness levels, the use of strategies to amplify or dampen
46 positive emotions, and recalled happiness at the end of each day. Our findings revealed some
47 interesting patterns. First, we found that on days when participants amplified positive emotions
48 more and dampened them less, they were more likely to recall higher happiness levels.
49 Participants with more severe depressive symptoms reported lower recalled happiness, even on
50 days when they felt quite happy. Yet, there was a silver lining: on days when these individuals
51 increased their use of amplifying strategies, their recalled happiness also went up. On the flip
52 side, reducing these strategies led to a decline in their memory of happiness.

53 These findings suggest that amplifying strategies could be a valuable tool in helping those with
54 depressive symptoms remember positive experiences more positively. By focusing on
55 enhancing these emotional skills, we may be able to mitigate the positive affect recall bias
56 associated with depression. Encouraging the practice of these strategies in everyday life could
57 be a crucial step towards fostering a more positive outlook for individuals struggling with
58 depressive symptoms.

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62 **WAS I HAPPY TODAY? THE INFLUENCE OF POSITIVE EMOTION REGULATION**
63 **AND DEPRESSIVE SYMPTOMS ON RECALLED HAPPINESS**

64 Recalling positive emotional experiences, known as positive reminiscence, is a powerful
65 strategy for eliciting positive emotions (Bryant et al., 2005). However, memories are often
66 biased. Such biases are commonly considered for specific episodes; for example, when the
67 emotions felt during an event differ from how they are later recalled (Schacter, 2021). However,
68 general recollections of daily affective experiences - independent of any particular event - are
69 also prone to distortions (Hedges et al., 1985). This phenomenon is known as *affect recall bias*
70 (Colombo et al., 2020).

71 Affect recall bias is typically assessed by comparing multiple momentary affect ratings
72 collected throughout the day with retrospective reports summarizing the overall affective
73 experience (e.g., Colombo et al., 2020; Ben-Zeev et al., 2009; Thomas & Diener, 1990).
74 Specifically, positive affect recall bias (i.e., biases in the recall of pleasant affective states) has
75 garnered significant attention due to its relevance for well-being. Recalling past positive affect
76 as more intense than it actually was has been linked to greater resilience (Colombo et al., 2020),
77 suggesting that such bias may help sustain emotional well-being (Bryant, 1989; Colombo et al.,
78 2020). Yet, some individuals - particularly those with higher depressive symptoms - struggle to
79 recall daily positive affective states, often remembering them as less positive than they were
80 originally experienced (Ben-Zeev et al., 2009). This maladaptive bias has also been linked to
81 lower resilience and heightened vulnerability to psychopathology (Ben-Zeev et al., 2009;
82 Colombo et al., 2020; Gaddy & Ingram, 2014). Understanding the mechanisms underlying this
83 bias is therefore essential for developing strategies that support well-being, especially in
84 populations at risk for depression.

85 One potential contributor to positive affect recall bias is positive emotion regulation - the
86 strategies individuals use to modulate positive emotional states (Quoidbach et al., 2015).

87 Amplifying strategies aim to generate, intensify, and prolong positive emotional experiences,
88 whereas dampening involves the tendency to respond to positive states with strategies that
89 decrease their intensity and duration (Bryant & Veroff, 2007; Feldman et al., 2008). Prior
90 research focusing on negative emotions has demonstrated that emotion regulation significantly
91 influences emotional salience. For example, using cognitive reappraisal during a negative daily
92 event has been shown to lead individuals to retrospectively underestimate the event's negativity
93 compared with ratings provided at the time of experience (Colombo et al., 2021). In contrast,
94 those who engage in higher levels of rumination and lower acceptance tend to experience
95 greater emotional involvement with the unpleasant experience one week and one month later
96 (Colombo et al., 2021; Colombo et al., 2024). Despite this, the role of positive emotion regulation
97 in memory processes, and more specifically in positive affect recall bias, remains almost
98 underexplored.

99 One well-established mechanism that may link positive emotion regulation to positive affect
100 recall bias is mood-congruent memory (Faul & LaBar, 2022), the tendency to recall information
101 that aligns with one's emotional state at the time of retrieval. Accordingly, one's current
102 affective state, potentially shaped by specific emotion regulation strategies applied during recall,
103 may bias how past experiences are remembered. For example, Dunn et al. (2018) found that the
104 use of dampening during the recall of positive experiences increased sadness and reduced the
105 remembered positivity. Besides, positive emotion regulation may also influence memory by
106 acting at the time of the original experience. Bryant and Veroff (2007) proposed that amplifying
107 strategies, in contrast to dampening ones, may enhance perceptual sensitivity to positive
108 experiences and amplify their emotional intensity, facilitating the recall of the associated
109 positive emotions and overall positivity. Consistent with this, using amplifying strategies during
110 pleasant daily experiences has been shown to predict more positively valenced and salient later
111 recollections (Colombo et al., 2024). Nevertheless, the extent to which positive emotion
112 regulation strategies applied during daily experiences contributes to positive affect recall bias
113 remains underexplored. Notably, individuals with higher depressive symptoms show reduced

114 ability to regulate positive emotions, being less likely to use amplifying strategies and more
115 likely to rely on dampening ones (Carl et al., 2013; Vanderlind et al., 2020). This maladaptive
116 regulation pattern may contribute to the positive affect recall bias commonly observed in this
117 population.

118 **The current study**

119 The present study aimed to clarify the roles of daily positive emotion regulation in shaping daily
120 recalled happiness and to examine the influence of depressive symptoms on this relationship.
121 Specifically, we tested the hypothesis that the positive emotion regulation strategies used during
122 the day would influence emotional recollection at the end of the day, potentially contributing to
123 biased happiness recall. Based on the existing literature, we formulated the following
124 hypotheses:

- 125 1. In line with Bryant and Veroff's (2007) framework, we hypothesized that greater daily use of
126 amplifying strategies and lower reliance on dampening would predict higher recalled
127 happiness, even when controlling for daily experienced happiness.
- 128 2. Individuals with higher depressive symptoms often experience both reduced positive affect
129 and impairments in regulating positive emotions (Carl et al., 2013; Vanderlind et al., 2020).
130 This maladaptive regulation can make positive experiences less intense and less salient, thus
131 leading to recall past happiness as less positive than it was experienced (Ben-Zeev et al.,
132 2009; Colombo et al., 2020). Consequently, depressive symptoms are expected not only to
133 bias overall recollections of happiness but also to weaken the association between daily
134 experienced happiness and later recalled happiness.

135 We also conducted an exploratory analysis to examine whether positive emotion regulation
136 moderates the relationship between depressive symptoms and happiness recall. Recent findings
137 suggest that positive emotion regulation difficulties in depression are more likely due to
138 challenges with implementation (i.e., frequency of use) rather than efficacy (Colombo et al.,

139 2024; Griffith et al., 2023; Vanderlind et al., 2022). Thus, we hypothesized that on days when
140 individuals with more depressive symptoms use more amplifying strategies and less dampening,
141 they would show less biased (i.e., more positive) happiness recall at the end of the day.

142 **Method**

143 **Sample**

144 Sample size was determined using power analysis. Rather than basing our power calculation on
145 effect sizes reported in previous studies, we preferred to use a threshold above which the effect
146 under investigation can be considered psychologically meaningful. This strategy has the
147 advantages of (1) anchoring the analysis in practical or psychological relevance, (2) avoiding
148 giving undue weight to negligible but statistically significant effects, and (3) not relying on
149 effect sizes derived from only two previous studies on the topic, both of which employed
150 somewhat different methodologies from ours (Ben-Zeev et al., 2009; Colombo et al., 2020).

151 The analyses most at risk of limited statistical power were those examining correlations between
152 individual differences in depression and positive emotion regulation with indicators of the
153 interplay between experienced and recalled happiness. If, by convention, we consider $r = 0.15$
154 as a weak correlation and $r = 0.30$ as a moderate correlation, then $r = 0.225$ indicates a weak-to-
155 moderate correlation. To identify effects of this size with 80% power and statistical significance
156 level at 0.05, a number of 152 participants was required, as determined using the *pwr package*
157 in R (Champely, 2020).

158 To be eligible for the study, participants had to be aged between 18 and 65 years and be able to
159 read and understand Spanish. Because impairments in positive emotion regulation and
160 anhedonia (i.e., reduced experience of joy and pleasure) are core symptoms of depression, we
161 excluded participants currently receiving pharmacological or psychological treatment ($n = 11$),
162 as treatment could alter the patterns observed in our main variables of interest. The final sample
163 included 155 individuals (80.6% female), with a mean age of 28.46 ($SD=12.26$; min: 18, max:
164 65). Mean education level, assessed continuously as the total number of years completed, was

165 16 years ($SD = 2.88$), which roughly corresponds to a bachelor's degree in the Spanish
166 education system. Most participants identified as Spanish (79.4%), with additional
167 representation from various countries including Latin America (7.1%), Italy (3.9%), Bulgaria
168 (3.2%), Poland (1.9%), the UK (1.3%), the USA (0.6%), Ukraine (0.6%), Romania (0.6%),
169 Morocco (0.6%), and China (0.6%).

170 **Procedure**

171 The protocol for the present study received approval from the ethics committee of Jaume I
172 University (certificate number: CEISH/53/2023) and was pre-registered on OSF (Colombo,
173 2023). The main hypotheses, study design, assessment measures, and planned statistical models
174 (i.e., linear mixed-effects models) outlined in the pre-registration remained unchanged.
175 However, whereas the original plan aimed to examine how affect recall bias, influenced by
176 positive emotion regulation strategies, relates to positive mental health, we ultimately focused
177 on depression, given its well-established association with positive affect recall bias (Ben-Zeev
178 et al., 2009; Colombo et al., 2020). Exploratory analyses (moderation models) were not pre-
179 registered.

180 Recruitment was conducted through community flyers and online advertisements, which
181 promoted a smartphone-based study investigating daily pleasant emotions and experiences.
182 Participants who met the inclusion criteria, as assessed through an online survey, were provided
183 with a link to sign the informed consent, complete baseline questionnaires and download the
184 mobile application mPath (<https://m-path.io/landing/>), developed by the University of Leuven
185 (Mestdagh et al., 2023). The study design was chosen in line with current methodological
186 recommendations. Although findings in the literature are sometimes mixed and
187 recommendations remain under debate, prior work generally advises avoiding more than six
188 prompts per day for longer than three weeks (Doherty et al., 2020). Semi-randomized time-
189 contingent schedules (e.g., one random prompt within a fixed interval) are considered optimal
190 because they minimize adaptation to predictable schedules, with items being typically phrased

191 to capture experiences “since the last survey” (Kuppens et al., 2022). Sampling frequency is
192 also debated, but evidence suggests that emotional episodes can last from 10 seconds to 24
193 hours, with a median duration of about 1 hour 25 minutes. At the same time, practical
194 constraints must be considered, since higher sampling frequency (Kuppens et al., 2022) and
195 longer questionnaires (Eisele et al., 2020) can reduce compliance. Balancing these
196 considerations, we adopted a 10-day semi-randomized sampling design with six prompts per
197 day, with each assessment including a maximum of 12 items to ensure data quality while
198 minimizing participant burden. Five of these notifications were sent semi-randomly within five-
199 time windows to assess positive emotion regulation and happiness levels: between 8:30 a.m. and
200 10:30 a.m., between 11:00 a.m. and 1:00 p.m., between 1:30 p.m. and 3:30 p.m., between 4:00
201 p.m. and 6:00 p.m., and between 7:00 p.m. and 8:30 p.m. The sixth notification was sent at 9:00
202 p.m. to retrospectively assess daily happiness levels.

203 **Measures**

204 *Baseline measures*

205 Depressive symptomatology was assessed at baseline using the Spanish version of the Patient
206 Health Questionnaire (PHQ-9). The PHQ-9 has demonstrated good sensitivity (.88 for the
207 original version; .87 for the Spanish adaptation), specificity (.88 for both versions), and internal
208 consistency ($\alpha = .89$ in both versions) (Diez-Quevedo et al., 2001; Kroenke et al., 2001; Muñoz-
209 Navarro et al., 2017). Cronbach alpha for the PHQ-9 in this study was acceptable ($\alpha=.77$). It
210 consists of 9 items corresponding to the DSM criteria for major depressive disorder (e.g., “Little
211 interest and pleasure in doing things”; “Feeling down, depressed, or hopeless”), with each item
212 rated on a 4-point scale from 0 (“not at all”) to 3 (“nearly every day”). Total scores range from 0
213 to 27, with higher scores indicating greater symptom severity. In our sample, the mean score
214 was 6.74 (min=1, max=20; $SD = 4.08$). Specifically, 54 participants reported no significant
215 depressive symptoms (PHQ-9 ≤ 4), 65 participants presented mild depressive symptoms (5 \leq
216 PHQ-9 ≤ 9) and 36 participants had moderate to moderately severe depressive symptoms (PHQ-
217 9 ≥ 10).

218 *Daily measures*

219 The full items included in the daily assessment can be accessed on OSF (Colombo, 2025). At
220 each prompt, amplifying strategies were assessed using items adapted from previous research
221 (Colombo et al., 2021, 2024) and based on Quoidbach et al.'s framework (2015). According to
222 this framework, amplifying strategies are categorized into four categories (Gross, 2015):
223 selecting or changing the situation, focusing or redirecting one's attention, changing the
224 interpretation of a stimulus, or modulating the response. The current study employed two items
225 for each category (i.e., 8 items in total), rated on a 0-100 scale ('Since the last prompt, to what
226 extent did you use the following strategies?' 0 = no adoption, 100 = high adoption). Averaging
227 the scores for the 8 items yielded the amplifying indicator for the analyses ($\alpha = 0.94$ at the
228 between-individual level and $\alpha = 0.80$ at the within-individual level). Besides, dampening was
229 assessed using an adapted version of the Response to Positive Affect (RPA) scale (Dunn et al.,
230 2018; Feldman et al., 2008). Previous studies have shown that the RPA has strong psychometric
231 qualities, including solid internal consistency and good test-retest reliability (Dempsey et al.,
232 2011; González et al., 2023; Raes et al., 2009). In line with prior daily studies (Griffith et al.,
233 2023; Vanderlind et al., 2022), we used an adapted version of the RPA dampening subscale,
234 selecting the three items with the highest factor loadings rated on a 1–4 Likert scale ('Since the
235 last prompt, how much have you been thinking: about things that could go wrong; that your
236 streak of luck is going to end soon; that you don't deserve to feel good?'). Averaging the scores
237 for the 3 items yielded the dampening indicator used in the present study ($\alpha = 0.91$ at the
238 between-individual level and $\alpha = 0.62$ at the within-individual level). Finally, participants rated
239 their perceived level of happiness on a 1-7 Likert scale ('Since the last prompt, to what extent
240 have you felt happy?'). At the end of the day, the same item was used to assess participants'
241 retrospective recall of daily happiness ('Today, to what extent have you felt happy?').

242 **Data analysis**

243 All data and codes behind these analyses have been made publicly available (Colombo, 2025).

244 All analyses were conducted using R (R Core Team, 2023).

245 Before conducting the analyses, we reorganized the data to create a dataset with two levels: day-
246 level and individual-level. Each row in this dataset represented one day and included
247 information on the average happiness experienced, the recalled happiness for that day, the
248 average use of dampening strategies, and the average use of amplifying strategies.
249 Consequently, the dataset comprised a total of 1,550 rows (i.e., 10 days for each of the 155
250 participants). In all analyses, age was included as a covariate to account for its potential
251 confounding effect on memory (Reed & Carstensen, 2012; Spaniol et al., 2008).

252 The first step aimed to investigate the association between positive emotion regulation and
253 recalled happiness using a linear mixed-effects model estimated with maximum likelihood
254 through the lmerTest R package (Kuznetsova et al., 2017). This model included a random
255 intercept for each participant. The outcome variable was daily recalled happiness, with
256 experienced happiness as the primary predictor to assess the extent to which end-of-day recalls
257 align with actual experiences. Amplifying and dampening strategies were also included to
258 explore whether these strategies significantly predict recalled happiness.

259 In the second linear mixed-effects model, we explored the role of depressive symptoms. The
260 outcome variable remained recalled happiness, with experienced happiness as main predictor.
261 Depressive symptomatology was included as further predictor (individual level) to examine
262 whether depressive symptoms predicted lower levels of recalled happiness at the end of the day.
263 The third and final predictor was the interaction between experienced happiness and depressive
264 symptoms to explore whether depression moderates the association between experienced and
265 recalled happiness.

266 The final step focused on the key constructs of dampening and amplifying strategies, testing
267 their potential moderating roles in the relationships observed in the second model. To this end,
268 the linear mixed-effects model described above was performed with the addition of the main
269 effects of dampening and amplifying (day level) as predictors, as well as the interactions

270 between dampening and amplifying and the previously mentioned predictors. If the above-
271 mentioned effects interacted with dampening and/or amplifying, it would suggest that the way
272 individuals regulate their emotions alters these effects.

273 **Results**

274 **Descriptive statistics**

275 In our sample, the mean compliance rate - defined as the percentage of prompts answered out of
276 those delivered - was 68.8% ($SD = 19.4\%$, range: 32% - 100%), corresponding to an average of
277 41.3 answered prompts out of 60 ($SD = 11.6$). Compliance was not significantly correlated with
278 depressive symptom severity ($r = .103$, $p = .202$). Moreover, a one-way ANOVA indicated no
279 significant differences in compliance levels between depression severity groups ($F(2, 152) =$
280 $.495$, $p = .611$). Specifically, mean compliance rates were 66.7% ($SD = 18.7$) for the low
281 depression group ($PHQ-9 \leq 4$), 69.5% ($SD = 19.7$) for the moderate depression group ($5 \leq$
282 $PHQ-9 \leq 9$), and 70.5% ($SD = 19.4$) for the high depression group ($PHQ-9 \geq 10$).

283 Descriptive statistics and intercorrelations between the variables of interest are set out in Table
284 1. Three potentially interesting results emerged at this descriptive level. First, consistency
285 between experienced and recalled happiness was generally strong but not perfect. Specifically,
286 experienced happiness was highly correlated with recalled happiness at both the between-person
287 level ($r = .86$, $p < .001$) and within-person level ($r = .74$, $p < .001$). However, the mean recalled
288 happiness ($M = 5.33$, $SD = .91$) was slightly, yet significantly, higher than the mean experienced
289 happiness ($M = 5.20$, $SD = .81$; Wilcoxon signed-rank test: $Z = 8089$, $p < 0.001$). Second,
290 recalled happiness was significantly correlated not only with experienced happiness but also
291 with the use of dampening (within-person: $r = -0.37$, $p < 0.001$; between-person: $r = -0.37$, $p <$
292 0.001) and amplifying strategies (within-person: $r = 0.44$, $p < 0.001$; between-person: $r = 0.49$,
293 $p < 0.001$), as well as depressive symptoms ($r = -0.45$, $p < 0.001$). Nonetheless, these findings
294 should be interpreted with caution, as they may primarily reflect the relationships among
295 depression, dampening and amplifying strategies, and experienced happiness, which, in turn,

296 may influence remembered happiness. Finally, depressive symptoms were associated with a
 297 general greater use of dampening ($r = 0.49, p < 0.001$) and lower implementation of amplifying
 298 strategies ($r = -0.16, p < 0.001$).

299 *Table 1*

300 *Descriptive statistics and intercorrelations between the variables assessed in the present study.*

Variable	<i>M</i>	<i>SD</i>	<i>Sk</i>	<i>ICC</i>	1	2	3	4
1. R-Happ	5.20	.81	-0.81		1			
2. E-Happ	5.33	.91	-0.96		.74	1		
3. Dampening	1.51	0.62	1.54	0.71	-.37	-.41	1	
4. Amplifying	56.34	18.45	-0.09	0.67	.44	.56	-.10	1
5. Depression	6.74	4.08	0.85		-.45	-.42	.49	-.16

301 *Note.* R-Happ: recalled happiness; E-Happ: experienced happiness; *M*: mean; *SD*: standard deviation; *Sk*:
 302 skewness; *ICC*: intraclass correlation (i.e., the proportion of the variance in the variable that is explained
 303 by stable between-individual differences). Descriptive statistics and correlations involving depression
 304 were computed at the individual level ($n = 155$). Descriptive statistics and correlations involving other
 305 variables were computed at the day level ($n = 1550$). All correlations were statistically significant at the p
 306 < 0.001 level, except the correlation between depression and amplifying that was significant at the $p <$
 307 0.05 level.

308

309 **Hypotheses testing**

310 First, we examined the relationship between daily positive emotion regulation and recalled
 311 happiness (Table 2).

312 *Table 2*

313 *Results of the linear mixed-effects model exploring the relationship between daily positive emotion*
 314 *regulation and recalled happiness.*

Predictor	<i>beta</i>	<i>SE</i>	<i>Pr(> t)</i>	<i>95% CI</i>
(Intercept)	0.121	0.063	0.065	[-0.01, 0.25]
E-Happ	0.631	0.029	< 0.001	[0.57, 0.69]
Amplifying	0.081	0.029	0.005	[0.02, 0.14]
Dampening	-0.101	0.025	< 0.001	[-0.15, -0.01]

315 *Note.* *SE*: standard error; E-Happ: experienced happiness.

316

317 Individuals' recalled happiness for the day was strongly predicted by their experienced

318 happiness ($\beta = 0.63, SE = 0.03, p < 0.001$). Moreover, daily recalled happiness was significantly
 319 associated with daily use of amplifying strategies ($\beta = 0.08, SE = 0.03, p = 0.005$) and
 320 dampening strategies ($\beta = -0.10, SE = 0.03, p < 0.001$). These findings suggest that higher use
 321 of amplifying and lower use of dampening strategies was linked to higher levels of recalled
 322 happiness, even when controlling for daily happiness ratings.

323 In relation to depression, mixed supports for our hypotheses were obtained (Table 3).
 324 Controlling for experienced happiness ($\beta = 0.70, SE = 0.02, p < 0.001$), depressive symptoms
 325 significantly predicted recalled happiness ($\beta = -0.11, SE = 0.03, p < 0.001$). This relationship
 326 was negative, suggesting that higher depressive symptoms were associated with lower levels of
 327 recalled happiness. However, the interaction between experienced happiness and depressive
 328 symptoms was not statistically significant ($\beta = -0.02, SE = 0.02, p = 0.350$).

329 *Table 3*

330 *Results of the linear mixed-effects model exploring the relationship between depression and recalled*
 331 *happiness.*

Predictor	<i>beta</i>	<i>SE</i>	<i>Pr(> t)</i>	<i>95% CI</i>
(Intercept)	0.129	0.060	0.036	[0.01, 0.25]
E-Happ	0.699	0.022	< 0.001	[0.66, 0.74]
Depression	-1.114	0.026	< 0.001	[-0.16, -0.06]
E-Happ * Depression	-0.018	0.020	0.350	[-0.06, 0.02]

332 *Note.* SE: standard error; E-Happ: experienced happiness.

333

334 The results of the last linear mixed-effects model to explore the moderating effect of positive
 335 emotion regulation are displayed in Table 4.

336 *Table 4*

337 *Results of the linear mixed-effects model performed exploring potential mediation or moderation effects.*

Predictor	<i>beta</i>	<i>SE</i>	<i>Pr(> t)</i>	<i>95% CI</i>
(Intercept)	0.165	0.067	0.014	[0.04, 0.30]
E-Happ	0.631	0.031	< 0.001	[0.57, 0.69]
Depression	-0.101	0.030	< 0.001	[-0.17, -0.05]

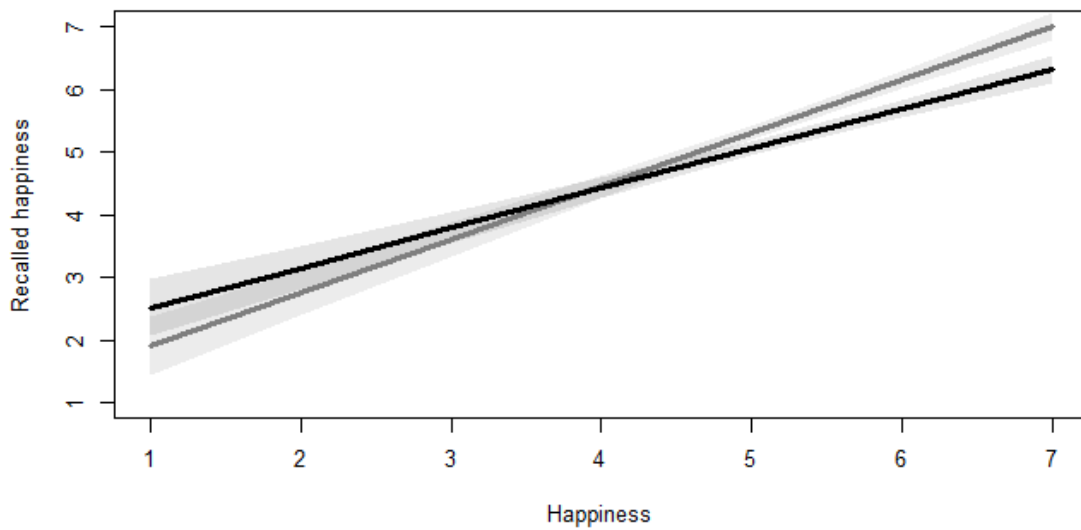
Amplifying	0.087	0.030	0.004	[0.03, 0.15]
Dampening	-0.065	0.029	0.024	[-0.12, -0.01]
E-Happ * Depression	-0.091	0.033	0.006	[-0.16, -0.03]
E-Happ * Amplifying	0.028	0.019	0.134	[-0.01, 0.07]
E-Happ * Dampening	0.015	0.021	0.481	[-0.03, 0.06]
Depression * Amplifying	0.103	0.030	0.001	[0.04, 0.16]
Depression * Dampening	-0.035	0.030	0.245	[-0.09, 0.02]
E-Happ * Depression * Amplifying	-0.018	0.019	0.343	[-0.05, 0.02]
E-Happ* Depression * Dampening	-0.020	0.019	0.292	[-0.06, 0.02]

338 *Note.* SE: standard error; E-Happ: experienced happiness.

339

340 In this model, depression significantly moderated the link between experienced and recalled
341 happiness ($\beta = -0.09$, $SE = 0.03$, $p = 0.006$), which suggests that emotion regulation variables
342 may account for variance unexplained in the previous model. Additionally, a significant
343 interaction between depression and amplifying strategies was observed ($\beta = 0.10$, $SE = 0.03$, $p =$
344 0.001).

345 These significant interactions are represented in Figure 1 and Figure 2. Predictions were
346 computed based on the parameters estimated by this model for low levels of depression (-1 SD;
347 PHQ-9 < 2.7, reflecting minimal or no depressive symptoms) and high levels of depression ($+1$
348 SD; PHQ-9 > 10.8, reflecting moderate to severe depressive symptoms). As shown in Figure 1,
349 individuals with more severe depressive symptoms recalled less daily happiness compared to
350 those with lower levels of depression, despite having experienced similar levels of happiness on
351 the same day.



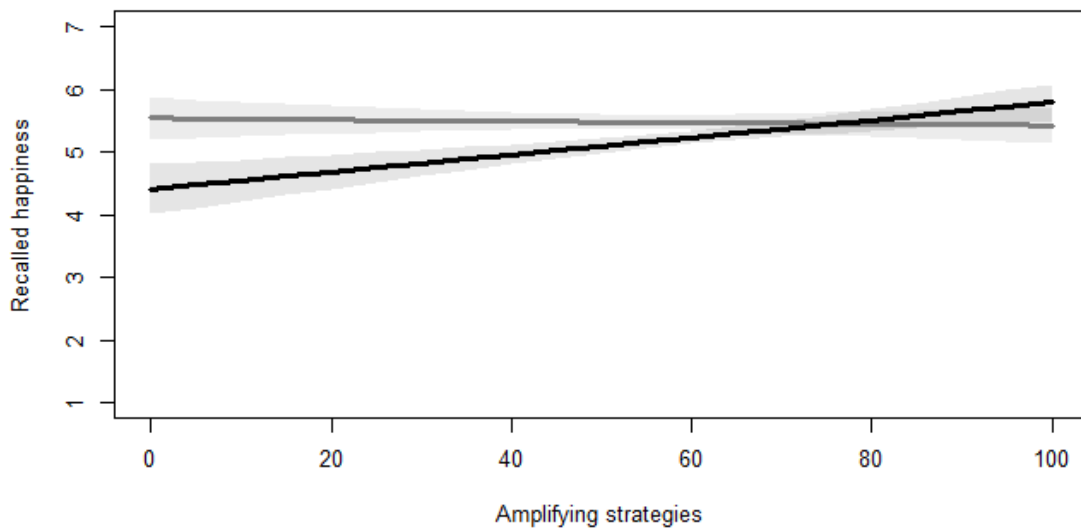
352

353 *Figure 1*

354 *Graphical representation of the association between happiness and remembered happiness moderated by*
 355 *depression. Grey lines correspond to individuals with low depression (-1SD), whereas black lines*
 356 *correspond to individuals with high depression (+1SD). Shaded areas around each line indicate 95%*
 357 *confidence intervals.*

358

359 Furthermore, the use of amplifying strategies was positively associated with recalled happiness
 360 among individuals with higher depressive symptoms, whereas no such relationship was
 361 observed for those with lower levels of depression (Figure 2). Specifically, for individuals with
 362 more severe depressive symptoms, increased use of amplifying strategies on a given day was
 363 linked to higher recalled happiness. Conversely, not implementing these strategies was linked to
 364 a diminished recall of daily happiness.



365

366 *Figure 2*

367 *Graphical representation of the association between daily use of amplifying strategies and remembered*
 368 *happiness moderated by depression. Grey lines correspond to individuals with low depression (i.e., -*
 369 *1SD), whereas black lines correspond to individuals with high depression (i.e., +1SD). Shaded areas*
 370 *around each line indicate 95% confidence intervals.*

371

372

Discussion

373 Our first hypothesis predicted that greater use of amplifying strategies and lower dampening
 374 would be associated with higher recalled happiness. Consistent with this, individuals who used
 375 more amplifying and fewer dampening strategies reported higher happiness recall at the end of
 376 the day. This effect may be explained through attentional mechanisms, whereby amplification
 377 strategies focus cognitive resources on pleasurable aspects of experiences, consequently
 378 enhancing the retrieval of the associated positive emotions (Bryant & Veroff, 2007).
 379 Conversely, dampening strategies may reduce recalled happiness by diverting attention away
 380 from positive experiences. Indeed, individuals who frequently use amplification strategies
 381 report more frequent positive daily events, possibly reflecting a heightened sensitivity to
 382 positive experiences (Jose et al., 2020). Together, individual differences in positive emotion
 383 regulation may influence the recall of daily positive affective states.

384 Supporting our second hypothesis and consistent with prior research (Ben-Zeev et al., 2009;
385 Colombo et al., 2020), depressive symptoms were associated with recalling happiness as lower
386 than originally reported. However, the interaction between experienced happiness and
387 depression was not significant. This interaction only became significant when amplifying and
388 dampening strategies were included into the model, highlighting that positive emotion
389 regulation may account for variance in happiness recall that would otherwise remain
390 unexplained.

391 The exploratory analysis also showed that depression moderated the relationship between
392 amplifying strategies and recalled happiness. Individuals with more severe symptoms showed
393 improved happiness recall on days when they employed more amplification strategies.
394 Altogether, those individuals may benefit more from amplifying strategies, potentially helping
395 counteract depression-related recall bias (Craske & Pontillo, 2001). This interpretation aligns
396 with recent ecological research suggesting that depression may impair the implementation rather
397 than the effectiveness of positive emotion regulation strategies. For instance, Vanderlind et al.
398 (2022) found that depression-related impairments in positive emotion regulation were primarily
399 linked to maladaptive strategy selection (i.e., greater dampening and less amplifying), rather
400 than to deficits in applying these strategies effectively. Similarly, Colombo et al. (2024) showed
401 that amplifying strategies were equally - if not more - effective in enhancing emotional well-
402 being among individuals with higher depressive symptoms, underscoring that the core issue
403 may lie in which strategies are chosen. Yet, the mechanisms underlying this maladaptive
404 implementation remain unclear. Individuals with depression often endorse dysfunctional
405 metacognitive beliefs: namely, beliefs about their own internal states and the coping strategies
406 that influence those states (Matthews & Wells, 2003; Sun et al., 2017). Emerging evidence
407 suggests that stronger endorsement of maladaptive metacognitive beliefs (e.g., “Feeling upset is
408 uncontrollable”) may hinder effective emotion regulation (Mansueto et al., 2022, 2024). This
409 could explain why individuals with more severe depressive symptoms are more likely to rely on
410 dysfunctional positive emotion regulation strategies.

411 The absence of significant moderation effects for dampening strategies warrants careful
412 consideration. This null finding may reflect measurement limitations. First, the dampening scale
413 demonstrated low within-person reliability, suggesting limited sensitivity to detect day-to-day
414 fluctuations. Additionally, questions remain about the construct's face validity. Although these
415 items have been employed in previous research (Griffith et al., 2023; Vanderlind et al., 2022),
416 they may reflect a more trait-like cognitive style associated with response to positive emotions
417 (e.g. “that your streak of luck is going to end soon”), rather than momentary, intentional efforts
418 to downregulate them. This is further supported by the high between-person reliability of the
419 dampening coefficient, indicating greater stability across individuals than variability within
420 them.

421 Overall, positive affect recall bias may undermine emotional well-being by reinforcing negative
422 self-perceptions (Everaert et al., 2012) and reducing the use of positive reminiscence (Joormann
423 et al., 2007). The use of amplifying strategies can modify the relationship between experienced
424 and recalled happiness in individuals with higher depressive symptoms. This distinction has
425 clinical relevance, highlighting the importance of targeting positive emotion regulation as a
426 factor that may improve the recall of daily pleasant experiences in depression. These results
427 align with a growing consensus that interventions for emotional disorders should emphasize
428 both symptom reduction and the enhancement of positive emotion regulation skills (Carl et al.,
429 2013; Craske et al., 2019; Díaz-García et al., 2021). However, whether more positive recall of
430 happy moments is inherently adaptive remains an open question. As Forgeard and Seligman
431 (2012) suggest, the most adaptive outlook may balance predominant optimism with realistic
432 pessimism, maintaining a generally positive outlook while retaining awareness of negative
433 outcomes.

434 *Limitations*

435 Regarding the sample, most participants were female, which may limit the generalizability of
436 the findings. Although substantial literature has documented gender differences in negative

437 emotion regulation (McRae et al., 2008), evidence concerning gender effects on positive
438 emotion regulation remains inconclusive. Some studies report higher amplifying tendencies
439 among women (Colombo et al., 2024; Kim & Bryant, 2017), while others failed to observe
440 significant differences (Goodall, 2015). Future research should seek to clarify the role of gender
441 in positive emotion regulation and positive affect recall bias. Additionally, only a small
442 proportion of the sample reported moderate-to-severe depressive symptoms ($n=36$). This could
443 explain the modest association observed between depressive symptoms and amplifying
444 strategies, a pattern consistent with previous findings from daily studies (e.g., Griffith et al.,
445 2023). Much of the evidence for reduced amplification in depression comes from retrospective
446 self-reports, which might be prone to bias (e.g., underreporting amplifying strategies). In
447 contrast, daily assessments may mitigate potential biases inherent in retrospective reports and
448 account for the different pattern of results.

449 In terms of measures, while the use of ad-hoc items to assess daily emotional dynamics has
450 increased considerably (Colombo et al., 2020), there remains a lack of validated questionnaires
451 specifically suited for such designs. Importantly, the dampening items showed low within-
452 person reliability, raising concerns about their sensitivity to daily fluctuations. Combined with
453 the face validity limitations discussed earlier, the dampening measure may not have adequately
454 captured the complexity of momentary emotion regulation. Moreover, the daily measures
455 employed different rating scales. Most variables were rated on 1-4 or 1-7 Likert scales to
456 preserve their validated formats, whereas amplifying strategies were assessed on a 0-100 scale,
457 which has been shown to better capture daily affective fluctuations (Haslbeck et al., 2025). This
458 measurement issue may represent an additional study limitation.

459 Finally, from a methodological standpoint, the correlational nature of this research prevents
460 causal conclusions from being drawn. Future research could employ experimental designs that
461 manipulate amplifying strategies in daily life to directly assess their impact on the recall of
462 positive emotions. Additionally, retrospective happiness assessments could present potential
463 limitations. First, daily retrospective reports may be influenced by the immediately preceding

464 momentary rating. However, prior research suggests this effect is minimal (Hedges et al., 1985).
465 In our data, the last momentary happiness rating ($r = .39, p < .001$) and the average daily
466 happiness score ($r = .37, p < .001$) were both significantly correlated with retrospective reports.
467 While the comparable magnitudes of these correlations suggest that the last rating might not be
468 the sole determinant of retrospective happiness, it may still have exerted some influence.
469 Second, retrospective reports may have been influenced by participants' mood and use of
470 strategies at the time of reporting, in line with the mood-congruent hypothesis. This may be
471 particularly relevant for participants with elevated depressive symptoms, who often display an
472 attentional bias favoring emotionally congruent information (Gaddy & Ingram, 2014; Mennen
473 et al., 2019). Although controlling for momentary mood and regulation strategies at recall could
474 have isolated these effects, it might also have biased reports by drawing attention to current
475 emotions. Future research should investigate the extent to which momentary mood influences
476 affect recall bias, particularly in individuals prone to mood-congruent biases.

477 **AUTHOR CONTRIBUTION**

478 *Desirée Colombo*: Conceptualization, Methodology, Formal Analysis, Investigation, Writing –
479 Original Draft. *Jean-Baptiste Pavani*: Formal Analysis, Writing – Review and Editing. *Rosa*
480 *María Baños*: Writing – Review and Editing, Supervision, Funding Acquisition. *Giovanni*
481 *Mansueto*: Conceptualization, Writing – Review and Editing. *María Folgado-Alufre*: Writing –
482 Review and Editing. *Juana María Bretón-López*: Supervision.

483

484 **OPEN SCIENCE AND TRANSPARENCY**

485 All data, materials and analysis code have been made publicly available and can be accessed at
486 https://osf.io/su4gm/?view_only=c6b995d17c8d45b3a616c210bb20c307.

487

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