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Research paper

Variability in emotion regulation strategy use in major depressive disorder: Flexibility or volatility?

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ABSTRACT

Background: Emotion regulation is critical for psychological health. Adaptive emotion regulation, in particular, requires the ability to flexibly use different strategies to meet situational demands. Such flexibility is often reflected in greater variability in everyday emotion regulation strategy use. Research on strategy variability has, to date, been positively associated with some emotional and psychological outcomes, but such research has exclusively focused on healthy individuals. Our investigation examines whether variability in emotion regulation strategy use and its implications differ between individuals with Major Depressive Disorder (MDD) and healthy controls.

Method: Using ecological momentary assessments (EMA), we assessed variability in emotion regulation strategy use (i.e., between-strategy variability) and its implications in individuals with current MDD and healthy controls (*Ns* = 94 and 90). Participants completed six surveys per day for 10 days, rating their emotional experiences and emotion regulation strategy use. They also rated indices of psychological health daily.

Results: Individuals with MDD had higher emotion regulation strategy variability than healthy controls. In healthy controls, higher strategy variability was linked to greater emotion regulation success and was unrelated to daily depressive symptoms. However, in individuals with MDD, higher strategy variability was not only unrelated or even negatively linked to emotion regulation success, but it was also associated with higher daily depressive symptoms.

Limitations: We did not assess the fit between regulatory strategies and contexts, and only included self-report measures collected through smartphones.

Conclusion: Variability in emotion regulation strategy use may capture adaptive flexibility among healthy individuals, but maladaptive volatility among individuals with MDD.

1. Introduction

Emotion regulation is critical for psychological health (Gross and John, 2003). Emotion regulation involves using various strategies to influence emotions (Gross, 2015). Adaptive emotion regulation, in particular, requires flexibility in strategy use – namely, the ability to flexibly use strategies that meet different situational demands (Aldao et al., 2015). Such flexibility has been operationalized as variability in emotion regulation strategy use. Emotion regulation strategy variability refers to variation in the use of emotion regulation strategies across situations and over time (Kalokerinos and Koval, 2024). In healthy samples, strategy variability has been linked to better emotional and psychological outcomes (Blanke et al., 2020; Wang et al., 2021). However, variable emotion regulation strategy use may not necessarily indicate flexibility (Aldao et al., 2015). Individuals may also use strategies at random, without taking situational demands into account. In such cases, higher strategy variability may reflect more erratic behavior rather than flexibility. Given that Major Depressive Disorder (MDD) is characterized by less context sensitivity and more difficulties in emotion regulation (Joormann and Stanton, 2016; Southward and Cheavens, 2017), strategy variability in emotion regulation may capture different processes in healthy individuals and those with MDD. In this investigation, we examined whether greater variability in emotion regulation strategy use is adaptive in healthy individuals, but potentially maladaptive in MDD.

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1.1. Emotion regulation strategy use in MDD

Emotion regulation can be achieved by using a variety of strategies (Gross, 2015). Some strategies are generally more effective than others in regulating emotions. For example, cognitive reappraisal (i.e., modifying the interpretation of an event to change its emotional impact) has been found to be effective in changing both emotional experience and expression, whereas rumination (i.e., dwelling on events and their causes) is generally less effective (Webb et al., 2012). Research examining emotion regulation strategies in MDD has shown that individuals with MDD tend to use effective strategies less and ineffective strategies more than healthy individuals (Liu and Thompson, 2017).

Whether or not a strategy is adaptive, however, depends on the context (Aldao, 2013). For instance, using cognitive reappraisal was more adaptive in uncontrollable situations, but less adaptive in controllable situations (Troy et al., 2013). Thus, adaptive emotion regualtion should be characterized not only by using more effective and less ineffective strategies in general, but also by using different emotion regulation strategies in a flexible manner (Aldao et al., 2015). Emotion regulation flexibility refers to the ability to shift regulatory efforts based on contextual demands (Aldao et al., 2015; Bonanno and Burton, 2013; Kalokerinos and Koval, 2024). People with higher (vs. lower) emotion regulation flexibility tend to be psychologically healthier (Chen and Bonanno, 2021). Therefore, to understand emotion regulation in MDD, it is important to examine not only which strategies people generally tend to use to regulate their emotions, but also the degree to which people use different strategies across contexts.

It is particularly important to study how people use different emotion regulation strategies across different contexts in daily life (Kalokerinos and Koval, 2024). Tracking emotion regulation in daily life allows researchers to examine how strategies vary across contexts, as individuals respond to personally-relevant events. Only a few studies to date have examined strategy use in emotion regulation in MDD in daily life. These studies have primarily focused on specific strategies and their findings are not always consistent with those from laboratory studies. For example, in an ecological momentary assessments (EMA) study, Liu et al. (2023) found that although individuals with current MDD used distraction more than healthy controls, the two groups did not differ in their use of other strategies, including reappraisal and acceptance. These findings suggest that compared to healthy controls, individuals with MDD might even use various regulatory strategies to a greater extent in daily life, potentially because they have higher needs for regulation (i.e., experiencing more intense unpleasant emotions; Hu et al., 2024a). However, to our knowledge, no studies to date have assessed variability in emotion regulation strategy use in MDD. The current investigation was designed to fill this gap.

1.2. Strategy variability in emotion regulation

One key index that has been used to study emotion regulation flexibility in daily life is emotion regulation strategy variability. Strategy variability can be operationalized as either between-strategy or within-strategy variability (Blanke et al., 2020). Between-strategy variability reflects the extent to which individuals use different strategies at different intensities at a specific moment in time. For instance, when feeling anger toward a superior at work, a person with lower between-strategy variability may use multiple strategies (e.g., distraction, acceptance, expressive suppression) to a similar extent, whereas a person with higher between-strategy variability may rely primarily on one strategy (e.g., expressive suppression). Between-strategy variability has been generally associated with more positive and less negative outcomes, indicating its adaptive value in emotion regulation. For example, between-strategy variability has been positively associated with lower unpleasant emotions (Blanke et al., 2020; Wenzel et al., 2022) and negatively associated with depressive symptoms (Elkjær et al., 2022; Wang et al., 2021).

Within-strategy variability indicates the extent to which individuals use one strategy at different intensities over time. For instance, a person with lower (vs. higher) within-strategy variability may be more likely to use expressive suppression consistently across different situations. Contrary to between-strategy variability, findings on the implications of within-strategy variability are mixed. For example, across multiple EMA studies, Blanke et al. (2020) found a null or very weak relationship between within-strategy variability and unpleasant emotions. With respect to psychological health outcomes, Wang et al. (2021) found no link between average within-strategy variability and depressive symptoms, whereas others even found that within-strategy variability was positively linked to depressive symptoms (Blanke et al., 2020) and negatively linked to life satisfaction (Elkjær et al., 2022). Thus, compared to between-strategy variability, the adaptive value of within-strategy variability is less clear.

To date, all research on strategy variability in emotion regulation targeted healthy samples. Healthy (vs. disordered) individuals generally have fewer deficits in emotion regulation (Joormann and Stanton, 2016). Therefore, it is likely that in such samples, between-strategy variability captures regulatory flexibility. High variability may occur when people prioritize strategies that match situational demands (Blanke et al., 2020), and therefore should be associated with greater emotion regulation success and psychological health (Kashdan and Rottenberg, 2010).

However, high between-strategy variability may also occur when the regulator randomly uses different strategies at a specific moment in time, regardless of what the situation calls for (Aldao et al., 2015). For example, a person who is not skilled at emotion regulation may use rumination as the primary strategy for regulating anger toward their superior. This person would have similarly high between-strategy variability as the person who primarily uses expressive suppression, but it is unlikely that in this situation, rumination would lead to instrumental outcomes. Such cases may reflect more erratic use of emotion regulation strategies (i.e., greater volatility), rather than flexibility. In these cases, greater strategy variability may no longer facilitate and might even impair emotion regulation success and psychological health (Aldao et al., 2015).

MDD is characterized by lower regulatory ability and less contextual sensitivity (Joormann and Stanton, 2016; Southward and Cheavens, 2017). Therefore, it is possible that in MDD, greater between-strategy variability in emotion regulation may indicate volatility rather than flexibility. If this is the case, greater strategy variability in MDD (but not in healthy individuals) will be linked to less emotion regulation success and poorer psychological health. To test this hypothesis, we examined variability in emotion regulation strategy use and its associations with emotion regulation success and psychological health in MDD. Given the mixed findings on within-strategy variability in healthy samples, we focused on between-strategy variability.[1]

1.3. Study overview

To assess emotion regulation strategy variability in MDD and its implications, we ran an EMA study, in which we compared participants diagnosed with current MDD to a comparable group of healthy participants. All participants reported on their use of different emotion regulation strategies six times a day for 10 days. We measured participants' use of eight strategies to decrease unpleasant emotions — the most common form of daily emotion regulation (Kalokerinos et al., 2017). To sample a range of strategies, we focused on those that have been highlighted in the Process Model of Emotion Regulation (Gross, 2015) and assessed in prior EMA studies of emotion regulation (Hu et al., 2024a;

[1] Although the main text focuses on between-strategy variability, the Supplemental Materials report analyses and results regarding within-strategy variability.

Liu et al., 2023). To assess the implications of strategy variability, we examined momentary emotion regulation success and daily psychological health. To this end, in each EMA survey, participants reported on both unpleasant and pleasant emotional experiences. We operationalized emotion regulation success by modeling momentary emotional changes (i.e., decreases in unpleasant emotions and increases in pleasant emotions). Participants also rated indices of psychological health at the end of each sampling day. We tested whether individuals with MDD differed from healthy controls in their between-strategy variability and whether such variability was differentially associated with adaptive outcomes (i.e., emotion regulation success and psychological health) in the two groups.

2. Method

2.1. Transparency and openness

The study was part of a larger project investigating everyday emotion regulation efforts in MDD. The project was approved by the university's ethics committee. The methods of the larger project were preregistered (https://aspredicted.org/9MS_R71), but the present hypotheses were not. We report all data exclusions and measures relevant to the present investigation. Study materials, data, and statistical code are available at https://osf.io/2kmt9/?view_only=a00edf1cd4e747ff87a4d74b8c2b7835.

2.2. Participants

Our final sample included 184 individuals (150 females and 34 males, $M_{age} = 24.28$, $SD_{age} = 2.37$): 94 individuals who were clinically diagnosed with current MDD and 90 individuals who never experienced any mental health disorders (see Table S1 in Supplemental Materials for more demographic information). The larger project preregistered a minimum sample of 120 participants, based on analysis of previous EMA data from our lab that found an interaction between emotion regulation efforts and depression on affect ($b = -0.06$; $t = -2.44$, with a random intercept-only model; see Hu et al., 2024b, Study 2), using the summary-statistics-based power analysis (Murayama et al., 2022). We oversampled to recruit 189 participants at baseline. Among those, 184 participated in the EMA phase of the study.

2.3. Recruitment and diagnosis of MDD

We administered the Beck Depression Inventory-II (BDI-II; Beck et al., 1996) to 5005 university students to identify those who might meet the criteria for MDD. Participants aged 18–29 who likely met diagnostic criteria for our target groups (Depressed: BDI-II score ≥ 16; Nondepressed: BDI-II score ≤ 6) were invited for a clinical interview. We used the Diagnostic Interview for Anxiety, Mood, and OCD and Related Neuropsychiatric Disorders (DIAMOND; Tolin et al., 2018) to determine diagnostic status. The interviews were audiotaped and conducted by trained clinical psychology students. Participants in the MDD group were diagnosed with current MDD. Participants with bipolar I or II diagnoses or any psychotic disorder were excluded. To assess interrater reliability, we randomly selected 20% of interviews. Evaluators agreed on 97% of diagnoses, $k = 0.96$, $p < .001$.

2.4. Procedure

The larger project included a baseline assessment, an EMA study, and a follow-up. The present investigation focuses on the EMA data. Participants received EMA survey notifications on their smartphones via the application SEMA[3] (O'Brien et al., 2024). Notifications were scheduled to occur six times a day for 10 days, between 10 am and 10 pm. To ensure equal survey distribution throughout the day, surveys were scheduled using a stratified random interval scheme, dividing the day into six equal windows. Participants received an EMA prompt at a random time within the first 45 min of each window, with at least 30 min between prompts to avoid overlap. Upon receiving the prompt, participants had 30 min to complete the survey. In each EMA survey, participants reported on their emotional experiences and implementation of emotion regulation strategies. Additionally, in the last EMA survey on each sampling day, participants reported their daily psychological health. Participants received up to 50.5 USD or 19 course credits for finishing the entire EMA study.

2.5. Measures

All measures were completed on a 1 = *not at all* to 9 = *very much* scale.

2.5.1. Emotional experiences

Participants rated the extent to which they experienced each discrete emotion in the last 2 h. We averaged across items to create an index for unpleasant (i.e., anxious and sad; $\omega_{between} = 0.88$, $\omega_{within} = 0.54$) and pleasant (i.e., happy and calm; $\omega_{between} = 0.88$, $\omega_{within} = 0.60$) emotions, respectively.

2.5.2. Emotion regulation strategies

Participants indicated the extent to which they used each of the following strategies to decrease their unpleasant emotions in the past 2 h (Kalokerinos et al., 2017): situation selection ("*I tried to choose to do things that would make me feel less bad*"), rumination ("*I focused on what made me feel bad and thought about it over and over again*"), distraction ("*I tried to distract my mind away from what made me feel bad and think about other things*"), reappraisal ("*I changed the way I think about things, so they became less negative*"), acceptance ("*I tried to accept my negative emotions as they are, without judging them*"), expressive suppression ("I avoided expressing my negative emotions"), regulating the body ("I tried to change my bodily sensations (e.g., breaths, heart beats, sleep)"), and social support-seeking ("*I tried to approach someone who would make me feel less bad*").

2.5.2.1. Strategy variability indices. We calculated between-strategy variability, which represented variation in the employment of different strategies at each measurement occasion (Blanke et al., 2020). We calculated it as the *SD* of all strategies at a given moment and standardized on the maximum possible SD of all strategies at that moment to correct for the confound with the strategy mean (also called the relative between-strategy variability, see Wenzel et al., 2023).[2]

2.5.3. Daily psychological health

Participants rated seven items assessing their psychological health at the end of each sampling day, following the strategy measure. To get a more holistic evaluation of psychological health, we measured both the negative and positive aspects of psychological health. Three items assessed daily depressive symptoms, including depression ("*I felt depressed today*."), hopelessness ("*I felt hopeless today*."), and loneliness ("*I felt lonely today*."). These items were averaged to create a composite index of depressive symptoms (ω_{within}=0.71, $\omega_{between}$=0.95). Four items assessed daily well-being, including life satisfaction ("*I felt satisfied with my life today*."), purpose in life ("*I felt I have purpose in life today*."), perceived social connectedness ("*I felt connected to others today*."), and perceived physical health ("*I felt healthy today*."). These items were

[2] Results remain the same if we operationalized between-strategy variability as the SD of different strategies, without mean-correction. Additionally, we explored whether the effects of between-strategy variability were tied to specific strategies that have been identified as more effective versus ineffective in the literature. Overall, the results did not support this possibility (see Supplemental Materials).

averaged to create a composite index of well-being (ω_{within}=0.71, $\omega_{between}$=0.95).[3]

2.6. Data exclusion and analysis plan

Given the nested nature of the data (surveys nested with individuals), we conducted multilevel analyses to test our hypotheses in R (Version 4.1.1), using lme4 (Bates et al., 2015). In all models described below, continuous Level-1 predictors were person-mean centered.

2.6.1. Momentary-level analyses

A total of 8275 EMA surveys were collected. Per preregistration, we took three steps to ensure the quality of attention in EMA responses. First, we excluded careless responses (surveys submitted in <60 s; n = 40). Second, we excluded EMA surveys in which participants failed an attention check (n = 29). Third, we excluded EMA surveys in which participants had zero variance in responses (n = 0).[4] A total of 69 EMA surveys were excluded from further analyses (<1 % of the entire EMA sample). These exclusion criteria resulted in a final EMA sample of 8206 surveys ($M_{compliance}$ = 74.33 %, $SD_{compliance}$ = 23.14 %). MDD and healthy groups did not differ in compliance rates, p = .545.

2.6.1.1. Comparing strategy variability in healthy and MDD groups. We used a two-step model-building procedure to examine whether between-strategy variability ($SD_{between\text{-}strategy}$) varied as a function of depression on a moment-to-moment basis. In the first step, we fitted a multilevel regression model, where $SD_{between\text{-}strategy}$ was the dependent variable and depression was included at Level 2 as a predictor of the intercept. In the second step, we added mean strategy intensity ($M_{Strategy}$) at each assessment occasion as a Level-1 covariate, allowing its slope to vary randomly across persons, to control for the variability index's potential confound with mean strategy intensity (Dejonckheere et al., 2019).

2.6.1.2. Examining the link between strategy variability and emotion regulation success in healthy and MDD groups. We examined whether between-strategy variability *prospectively* predicted emotion regulation success (i.e., moment-to-moment changes in both unpleasant and pleasant emotions) and whether these associations differed by depression. First, we operationalized success in decreasing unpleasant emotions (UE) by subtracting UE_{t-1} from UE_t, and then predicted this difference score by $SD_{between\text{-}strategy}$ at t–1, depression, and their interaction.[5] We also added $M_{Strategy}$ at t–1 as a covariate. We only included random intercepts to avoid model convergence issues.[6] Next, we repeated the same analysis, predicting changes in pleasant emotions at t (difference in $PE_t = PE_t - PE_{t\text{-}1}$).

2.6.2. Daily-level analyses

A total of 1346 end-of-day (the last EMA survey of each day) surveys were received. On average, participants completed 74.78 % of end-of-day surveys (SD = 24.71 %).

2.6.2.1. Examining the link between strategy variability and daily psychological health in healthy and MDD groups. To assess the links between strategy variability and daily psychological health, we aggregated momentary measures ($SD_{between\text{-}strategy}$ and $M_{Strategy}$) to daily level so that the predictors and outcomes are on the same time scale. To conduct a conservative test of our hypothesis, we only included cases in which participants reported using at least one strategy to regulate emotions, for at least one occasion, during the day ($M_{Strategy} > 1$). This exclusion resulted in a final sample of 1205 daily observations.[7] The pattern of results remained similar without this data exclusion. We first ran a multilevel model, in which between-strategy variability (Level-1 predictor) interacted with depression to predict daily depressive symptoms, while controlling for mean strategy intensity (Level-1 covariate). Intercepts and slopes of $SD_{between\text{-}strategy}$ and $M_{Strategy}$ were allowed to vary. Next, we repeated the same analysis, predicting daily well-being.

3. Results

Table 1 presents the descriptive statistics. Below, we discuss findings on whether between-strategy variability differed by depression, and whether such variability was differentially linked to emotion regulation success (i.e., momentary changes in emotional experiences) and daily psychological health, between MDD and healthy groups.

3.1. Momentary-level analyses

3.1.1. Did strategy variability differ by depression?

As Table 2 shows, in Step 1, MDD group (M = 1.43, SD = 0.48) showed greater between-strategy variability than healthy group (M = 0.86, SD = 0.63), and this significant group difference held when controlling for the mean strategy intensity at each measurement occasion in Step 2, $ps < .001$, suggesting that on a moment-to-moment basis, individuals diagnosed with current MDD (vs. healthy controls) used different emotion regulation strategies more variably.

3.1.2. Did the link between strategy variability and emotion regulation success differ by depression?

First, we examined changes in unpleasant emotions. As Table 3 shows, the interaction between $SD_{between\text{-}strategy}$ at t-1 and depression on changes in unpleasant emotions at t was significant, p = .035. As Fig. 1A shows, between-strategy variability prospectively predicted decreases in unpleasant emotions among healthy controls, B = −0.22, SE = 0.06, p < .001, 95 % CI [−0.35, −0.10], but this association was not significant among individuals with MDD, B = −0.06, SE = 0.06, p = .320, 95 % CI [−0.19, 0.06]. The main effect of depression was not significant, p = .526, but the main effect of $SD_{between\text{-}strategy}$ was significant, p < .001, suggesting that overall, the more variably people used different strategies, the more successful they were at decreasing their unpleasant emotions subsequently.

With respect to results on changes in pleasant emotions, the interaction between $SD_{between\text{-}strategy}$ at t-1 and depression was also significant, p < .001. As Fig. 1B shows, between-strategy variability was

[3] Because the psychological health items had moderate-to-high correlations but were conceptually different, we conducted a factor analysis to evaluate if these items formed distinct factors. Results supported a two-factor solution – with depression, hopelessness, and loneliness loaded on one factor and life satisfaction, purpose in life, perceived social connectedness, and perceived physical health loaded on the second factor – which explained nearly 66 % of the variance.

[4] We preregistered to omit EMA items that responded more quickly than 650 ms (Geeraerts and Kuppens, 2020) – a criterion developed based on EMA studies conducted in Romance languages. In retrospect, we discovered that this criterion is irrelevant to the present context, as the project was conducted in a non-Romance language, resulting in different reaction times (Li et al., 1993). Given that following this exclusion criterion would have led to substantial data exclusion, we did not apply it during data cleaning.

[5] Two statistical approaches have been used to analyze momentary change (Lord, 1967): the autoregressive model and the difference score approach. In Supplemental Materials, we discuss both approaches and why the difference score is more proper in the present investigation.

[6] To conduct consistent analyses for unpleasant and pleasant emotions, we only kept random intercepts. The models with additional nonconverging random slopes yielded similar patterns of results.

[7] Among the 141 excluded daily observations, nondepressed individuals (M = 4.84, SD = 2.06), on average, were more likely to report not using any strategies to regulate during the day than depressed individuals (M = 1.50, SD = 0.58), p < .001. We therefore also repeated all analyses controlling for the number of surveys completed; results remained identical.

Table 1
Descriptive statistics in the entire sample and in healthy and MDD groups.

Variables	Entire sample				Healthy group				MDD group			
	M	$SD_{within\text{-}person}$	$SD_{Between\text{-}person}$	ICC	M	$SD_{within\text{-}person}$	$SD_{Between\text{-}person}$	ICC	M	$SD_{within\text{-}person}$	$SD_{Between\text{-}person}$	ICC
Between-strategy variability	1.15	0.50	0.63	0.59	0.86	0.51	0.63	0.56	1.43	0.49	0.48	0.46
$M_{Strategy}$	2.79	0.85	1.17	0.65	2.19	0.77	1.03	0.61	3.36	0.92	1.01	0.53
Situation selection	3.76	1.87	1.83	0.46	2.98	1.64	1.79	0.50	4.52	2.09	1.53	0.32
Rumination	2.08	1.16	1.18	0.40	1.46	0.70	0.75	0.39	2.67	1.59	1.22	0.31
Distraction	3.64	1.83	1.84	0.48	2.66	1.47	1.68	0.53	4.58	2.16	1.47	0.29
Reappraisal	2.39	1.38	1.24	0.41	2.10	1.25	1.20	0.43	2.66	1.50	1.23	0.37
Acceptance	2.77	1.45	1.52	0.47	2.48	1.40	1.55	0.47	3.04	1.50	1.45	0.44
Social support-seeking	2.51	1.69	1.36	0.35	2.11	1.41	1.31	0.42	2.88	1.96	1.31	0.26
Expressive suppression	2.73	1.56	1.71	0.48	1.90	1.13	1.10	0.36	3.53	1.97	1.81	0.43
Regulate the body	2.45	1.47	1.44	0.42	1.86	1.17	1.09	0.38	3.02	1.76	1.50	0.37
Unpleasant emotions	2.65	1.16	1.31	0.51	1.75	0.81	0.70	0.38	3.51	1.49	1.17	0.35
Pleasant emotions	4.52	1.37	1.47	0.52	5.32	1.34	1.29	0.47	3.75	1.39	1.20	0.40

Note. Between-person SD measures the variability of scores among different individuals and reflects how much individuals differ from each other. Within-person SD measures the variability of scores within the same individual over time and reflects how much an individual's scores differ from their own average score. ICC = intraclass correlation coefficient, which reflects the proportion of variance at the between-person level. Descriptives were calculated using the psych package in R (statsBy function; Revelle, 2017).

Table 2
Fixed effects from multilevel models: did strategy variability differ by depression?

Predictors	Step 1				Step 2			
	Estimate (SE)	*p*	95 % CI	R^2	Estimate (SE)	*p*	95 % CI	R^2
Intercept	0.85 (0.06)	<.001	[0.74, 0.97]	–	1.00 (0.06)	<.001	[0.89, 1.12]	–
Depression	0.58 (0.08)	<.001	[0.42, 0.74]	0.24	0.29 (0.07)	<.001	[0.14, 0.44]	0.17
$M_{strategy}$	–	–	–	–	0.46 (0.02)	<.001	[0.42, 0.51]	0.62

Note. Depression was coded 0 = healthy group, 1 = MDD group. Estimates and SE are unstandardized.

Table 3
Fixed effects from multilevel models: did the link between strategy variability and emotion regulation success differ by depression?

Predictors	Changes in unpleasant $emotions_t$				Changes in pleasant $emotions_t$			
	Estimate (SE)	*p*	95 % CI	R^2	Estimate (SE)	*p*	95 % CI	R^2
(Intercept)	−0.01 (0.03)	.630	[−0.07, 0.04]	–	0.09 (0.03)	.002	[0.03, 0.15]	–
Depression	−0.02 (0.04)	.526	[−0.10, 0.05]	0.00	−0.01 (0.04)	.892	[−0.09, 0.08]	0.00
$SD_{Between\text{-}strategy(t\text{-}1)}$	−0.22 (0.06)	<.001	[−0.35, −0.10]	0.00	0.13 (0.07)	.049	[0.00, 0.27]	0.00
$M_{Strategy\ (t\text{-}1)}$	−0.09 (0.03)	.005	[−0.15, −0.03]	0.00	−0.02 (0.03)	.559	[−0.09, 0.05]	0.00
$SD_{Between\text{-}strategy\ (t\text{-}1)}$ × Depression	0.16 (0.07)	.035	[0.01, 0.30]	0.00	−0.31 (0.08)	<.001	[−0.47, −0.16]	0.00

Note. Depression was coded 0 = healthy group, 1 = MDD group. Estimates and SE are unstandardized.

prospectively associated with increases in pleasant emotions among healthy controls, $B = 0.13$, $SE = 0.07$, $p = .049$, 95 % CI [0.00, 0.27], but decreases in pleasant emotions among individuals with MDD, $B = -0.18$, $SE = 0.07$, $p = .009$, 95 % CI [−0.32, −0.04]. The main effect of depression was not significant, $p = .892$, but the main effect of $SD_{between\text{-}strategy}$ was significant, $p = .049$, suggesting that overall, the more variably people used different strategies, the greater the increase in their pleasant emotions subsequently.

3.2. Daily-level analyses

3.2.1. Did the link between strategy variability and daily psychological health differ by depression?

First, we examined results on depressive symptoms. As Table 4 shows, the interaction between $SD_{between\text{-}strategy}$ and depression on depressive symptoms was significant, $p = .039$. As Fig. 2 shows, between-strategy variability was positively associated with depressive symptoms among individuals with MDD, $B = 0.47$, $SE = 0.21$, $p = .030$, 95 % CI [0.05, 0.89], but this association was not significant among healthy controls, $B = -0.06$, $SE = 0.24$, $p = .813$, 95 % CI [−0.53, 0.42]. The main effect of between-strategy variability was not significant, $p = .813$, but there was a significant main effect of depression, $p < .001$, indicating that MDD (vs. healthy) group had higher depressive symptoms overall.

With respect to results on well-being, the interaction between $SD_{between\text{-}strategy}$ and depression was not significant, $p = .599$. The main effect of between-strategy variability was not significant, $p = .835$, but there was a significant main effect of depression, $p < .001$, indicating that MDD (vs. healthy) group had lower well-being overall.

4. Discussion

This research is the first to examine emotion regulation strategy variability in MDD. Using an EMA design, we found that people with current MDD (vs. healthy individuals) had higher strategy variability, even after controlling for the mean level of strategy use. Thus, individuals with current MDD used different strategies more variably than healthy controls when regulating emotions in daily life. Next, we examined the implications of strategy variability for both emotion regulation success and psychological health in both healthy and MDD groups. Replicating prior research, we found that strategy variability was linked to positive outcomes among healthy controls, such that using

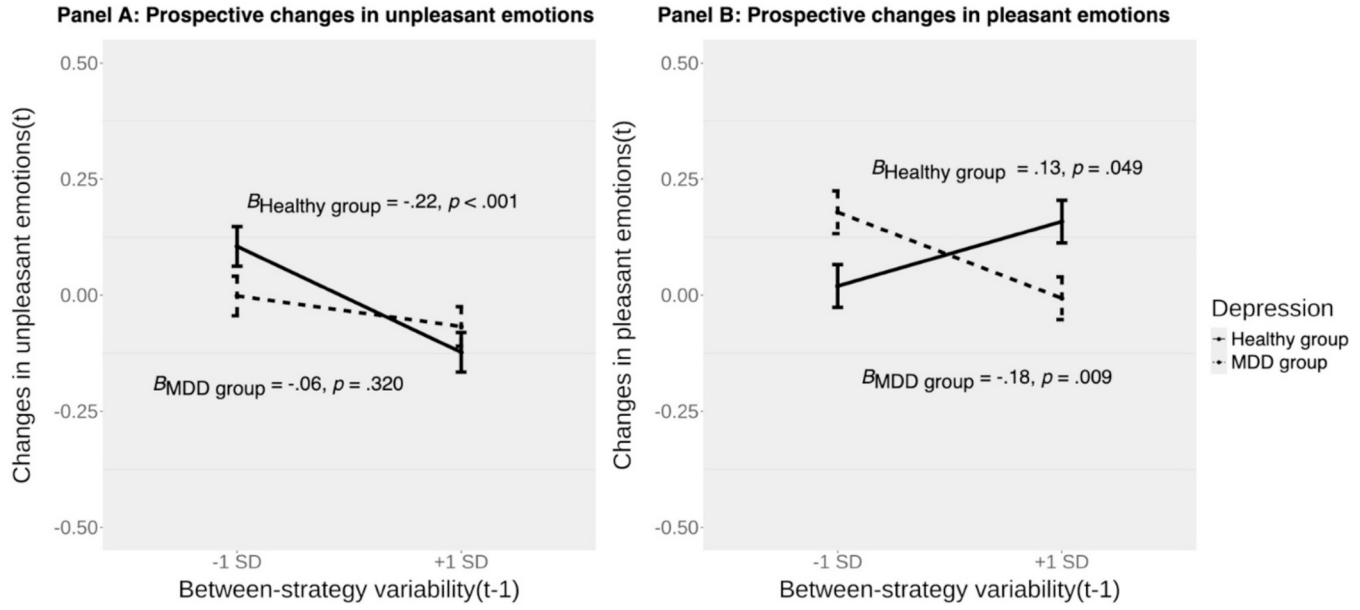

Fig. 1. Associations between strategy variability and emotion regulation success (A: prospective changes in unpleasant emotions and B: prospective changes in pleasant emotions) in MDD and healthy groups. *Note*. In panel A, changes in unpleasant emotions were computed such that higher values on the y-axis reflect smaller decreases in unpleasant emotions. In panel B, changes in pleasant emotions were computed such that higher values on the y-axis reflect greater increases in pleasant emotions.

Table 4
Fixed effects from multilevel models: did the link between strategy variability and daily psychological health differ by depression.

Predictors	Daily depressive symptoms				Daily well-being			
	Estimate (SE)	*p*	95 % CI	R^2	Estimate (SE)	*p*	95 % CI	R^2
(Intercept)	1.78 (0.12)	<.001	[1.54, 2.02]	–	5.88 (0.15)	<.001	[5.57, 6.18]	–
Depression	2.30 (0.17)	<.001	[1.97, 2.63]	0.39	−2.23 (0.21)	<.001	[−2.65, −1.81]	0.39
$SD_{\text{Between-strategy}}$	−0.06 (0.24)	.813	[−0.53, 0.42]	0.00	−0.05 (0.24)	.835	[−0.53, 0.43]	0.00
M_{Strategy}	0.11 (0.11)	.342	[−0.12, 0.33]	0.00	0.24 (0.11)	.035	[0.01, 0.48]	0.00
$SD_{\text{Between-strategy}}$ × Depression	0.53 (0.25)	.039	[0.02, 1.03]	0.00	−0.13 (0.24)	.599	[−0.61, 0.38]	0.00

Note. Depression was coded 0 = healthy group, 1 = MDD group. Estimates and SE are unstandardized.

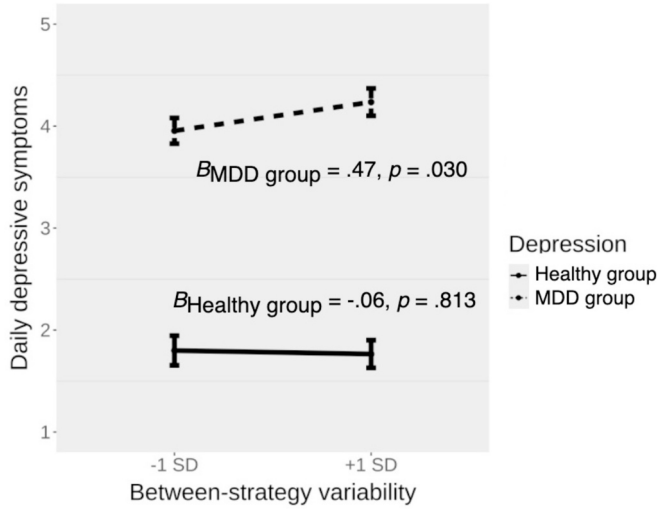

Fig. 2. Associations between strategy variability and daily depressive symptoms in MDD and healthy groups.

different strategies more variably to decrease unpleasant emotions prospectively predicted greater emotion regulation success (i.e., greater decreases in unpleasant emotions and greater increases in pleasant emotions). In contrast, among individuals with MDD, using different strategies more variably to decrease unpleasant emotions was unrelated or potentially even detrimental to emotion regulation success. Moreover, higher strategy variability during the day predicted higher depressive symptoms at the end of the day among individuals with current MDD, but not among healthy controls. All these results held even after accounting for the mean level of strategy use, suggesting that greater strategy variability may be beneficial for healthy individuals, but it is not necessarily beneficial and may even be detrimental for individuals with current MDD.[8]

4.1. Implications for understanding maladaptive emotion regulation in MDD

These findings promote the understanding of maladaptive emotion regulation in MDD by uncovering the dynamics of emotion regulation. Recent research on emotion regulation in daily life has shown that compared to healthy controls, individuals with MDD do not necessarily

[8] The Supplemental Materials present analyses on within-strategy variability. To summarize, both indices yielded similar results on emotion regulation success, with strategy variability negatively linked to regulatory success in depressed individuals, but not in healthy individuals. Unlike between-strategy variability, within-strategy variability was not linked to depressive symptoms but was associated with well-being.

use specific emotion regulation strategies less (Liu et al., 2023). So, what might underlie emotion regulation deficits in MDD? Our findings suggest that one type of deficit pertains to how depressed individuals use multiple strategies in conjunction. The use of different strategies is more variable in MDD. Rather than reflecting greater flexibility and an ability to match strategies to situational demands, such variability may reflect volatility, hindering successful emotion regulation and linking to worse depressive symptoms. These latter findings suggest that greater emotion regulation strategy variability might not only characterize MDD, but might contribute to its maintenance over time.

Why did individuals with MDD exhibit greater strategy variability in emotion regulation but did not benefit from such variability? We believe this might happen because depressed individuals have greater regulatory needs (Hu et al., 2024a) but they also have less context sensitivity or are less capable of choosing the strategy that is appropriate for the context (Aldao et al., 2015). As a result, depressed individuals might select various strategies to influence their emotions, without considering the fit of those strategies with the context or their goals. Consistent with these ideas, Millgram et al. (2023) found that people with MDD (vs. healthy controls) are more likely to use inappropriate strategies to regulate their emotions in daily life (e.g., using distraction to increase pleasant emotions). Alternatively, depressed individuals might select the appropriate strategies but fail to implement them properly. While prior work suggests that, with explicit instructions, individuals with MDD can effectively implement different emotion regulation strategies (Liu and Thompson, 2017), whether this holds true in daily life requires further investigation. Another possible explanation for why greater strategy variability appears to be maladaptive in MDD is that depressed individuals might be less capable of monitoring the efficacy of their chosen strategies in different contexts and then end up switching from one inappropriate strategy to another. Therefore, for depressed individuals, using more variable strategies to regulate emotions might impair their emotional and psychological health. Future work should unpack how different stages of the emotion regulation process relate to the present findings.

The current findings carry clinical implications. Many interventions for MDD have targeted maladaptive use of specific emotion regulation strategies (see Bailen and Thompson, 2023). Our findings suggest that it might be crucial to move beyond the focus on specific strategies. Adding more strategies to patients' repertoires, or encouraging them to use certain strategies over others, without considering the context, may not necessarily facilitate recovery. Instead, it might be critical to enhance patients' awareness of the regulatory context, help them identify strategies that may be more (or less) effective in certain contexts, and encourage them to practice implementing the right strategy in the right situation.

4.2. Implications for strategy variability in emotion regulation

Our findings also suggest that variability in emotion regulation strategy use is not a unitary construct. Instead, it may reflect different patterns of regulation that vary conceptually. Previous research has linked between-strategy variability to adaptive outcomes (Blanke et al., 2020; Wang et al., 2021), but such research was limited to psychologically healthy samples. These findings led to the conclusion that variability reflects regulatory flexibility and is beneficial. However, by assessing emotion regulation strategy use in unhealthy samples, we showed that such variability does not necessarily reflect flexibility. At least in some individuals, higher strategy variability might reflect regulatory volatility and be associated with maladaptive outcomes. Together, these findings highlight that the meaning of strategy variability might differ substantially as a function of sample characteristics.

4.3. Limitations and future directions

This investigation is the first to examine emotion regulation strategy variability in MDD, but it has some limitations. First, despite an emphasis on context, we did not measure specific situational characteristics or assess strategy-situation fit. For example, we could have assessed the controllability of events and the use of reappraisal (Troy et al., 2013). Relatedly, our assessment of emotion regulation success focuses on overall changes in emotions from one moment to another, but these momentary emotions might be tied to different situations. Thus, incorporating an understanding of the specific regulatory context in emotion regulation dynamics research, such as the strategy-situation match, is an important future direction.

Second, we assessed strategies to decrease unpleasant emotions, but did not measure strategies used to increase pleasant emotions or strategies used in contra-hedonic emotion regulation (e.g., decreasing pleasant emotions). Future research should test whether our findings replicate in other forms of emotion regulation.

Third, although we found that strategy variability was linked to greater daily depressive symptoms among individuals with MDD, we did not find significant links between strategy variability and indices of well-being. Ill-being and well-being represent distinct dimensions of psychological health (Ryff et al., 2006). Nonetheless, future research can test why emotion regulation strategy variability is linked to certain indices of psychological health and not others.

Finally, our investigation compared currently depressed individuals to healthy controls. Given that depression is recurrent (Sim et al., 2016), future research should examine if the present findings replicate in individuals with remitted depression, who also experience emotion regulation difficulties (Visted et al., 2018). Our study also focused on university students and relied on self-report assessments. Future work should extend these findings to other populations and age groups, and consider incorporating possible physiological measures into an EMA design to provide a more comprehensive understanding of emotion regulation dynamics in daily life.

4.4. Conclusion

This research tested emotion regulation strategy variability in MDD and healthy controls. We found that MDD is characterized by greater strategy variability in emotion regulation in daily life. Greater strategy variability was linked to more adaptive outcomes among healthy control. In contrast, greater strategy variability was not necessarily beneficial and even detrimental among individuals with MDD. These findings indicate that individuals with MDD use different emotion regulation strategies variably, but such variability may be counterproductive.

CRediT authorship contribution statement

Danfei Hu: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Maya Tamir:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

We have no conflicts of interest to disclose.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2024.12.027.

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