Emotion regulation flexibility and momentary affect in two cultures

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Recent theoretical models highlight the importance of emotion regulation (ER) flexibility, challenging traditional notions of universally maladaptive versus adaptive strategies. Here we employed ecological momentary assessment to develop proxy ecological measures for ER flexibility components (context sensitivity, repertoire and feedback responsiveness) and examine their associations with momentary affective outcomes in two independent samples from the United States (158 adults and 12,217 observations) and China (144 adults and 11,347 observations, analysis preregistered). Participants completed four daily surveys for 21 days, reporting emotional situations, situation characteristics, ER use and change and momentary distress. Increased momentary context sensitivity and use of repertoire were found associated with reduced distress, while results for feedback responsiveness were less consistent. Maintaining effective strategies was generally adaptive, whereas switching from ineffective strategies was adaptive for momentary depressed, but not anxious, mood. This innovative ecological momentary assessment design demonstrates transcultural similarities in ER flexibility's benefits and nuanced implications of its components on affective outcomes.

Emotion regulation (ER) plays a central role in mental health[1,2]. Although traditional theories and research on ER have classified strategies as either uniformly adaptive or maladaptive[1,3,4], recent theoretical models and empirical research have revisited the person–situation interactionist approach long existed in psychology[5–7] and demonstrated that the efficacy of specific ER strategies varies across situations and individuals[8–11]. The theoretical and empirical evidence have drawn attention to the importance of ER flexibility to navigating and managing diverse demands across various contexts[12–18].

From a theoretical perspective, flexibility has been conceptualized as a broad multicomponential process that involves a sequence of componential abilities[13,17]. Bonanno and Burton[13] elaborated three interrelated, yet functionally independent, components, later described as the flexibility sequence[19–21]: (1) the ability to evaluate contextual demands, or context sensitivity, (2) the access to a wide range of strategies that may be implemented to meet those demands, or repertoire, and (3) the capacity to monitor the efficacy of chosen strategies and modify as needed, or feedback responsiveness (Fig. 1). A related meta-analytic review of coping flexibility research proposed a similar flexibility model based on a systematic synthesis of empirical studies[17]. In this model, flexibility was conceptualized as abilities displayed at three unique yet closely interacted regulatory stages, respectively evaluating situational characteristics, adopting regulatory strategies and monitoring outcomes. Understanding these mechanistic components of flexibility holds critical implications for elucidating psychological explanations for resilience in the face of potential trauma[20,21]. Yet, despite converging evidence from both a top-down, heuristic approach[13] and a bottom-up, systematic approach[17]

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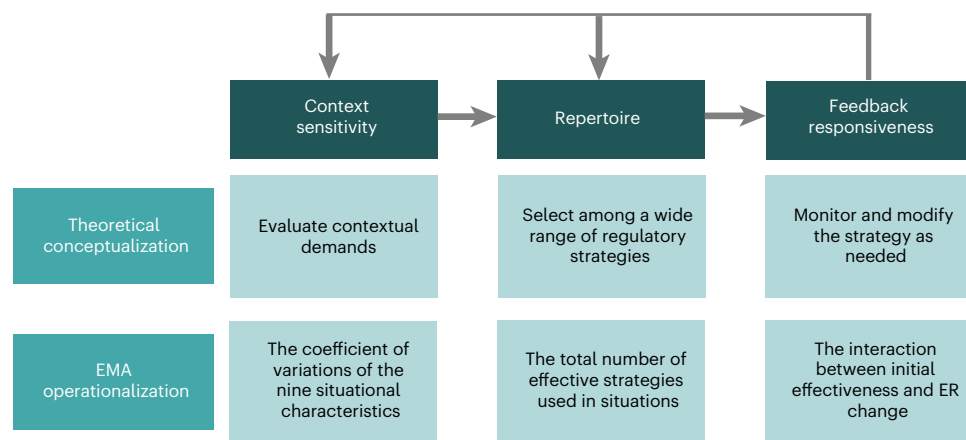
Fig. 1 | Flexibility components proposed by Bonanno and Burton (2013): theoretical conceptualization and EMA operationalization. Whether a strategy is effective is determined in an idiosyncratic approach. An ER strategy was considered effective for a participant, when across all EMA situations, the correlation between using this strategy and effectiveness (that is, the sum of increasing positive affect, decreasing negative affect and facilitating problem solving) was positive and at least small in size (that is, $r > 0.10$ (ref. 57)).

supporting the adaptiveness of all three flexibility components, there has been little research simultaneously examining these components in real-world, daily situations.

By definition, flexibility encompasses ER strategy–situation fit. However, the clinical literature has often focused on limited contextual domains such as stressor controllability and emotional intensity[11,22,23]. Social and personality psychologists have developed tools to assess situational characteristics[24–26], identifying eight fundamental characteristics of situations, respectively: duty, intellect, adversity, mating, positivity, negativity, deception and sociality (DIAMONDS). The DIAMONDS have been replicated across the globe[27,28] and can be measured by ultrabrief assessment[29]. Existing ecological momentary assessment (EMA) studies have used DIAMONDS to predict behaviors, emotions and interpersonal dynamics[24,26,30]. Capturing ER flexibility using EMA with comprehensive situational assessments, such as the DIAMONDS, holds important potential for measuring flexibility across diverse contexts where ER unfolds.

So far, examination of the context sensitivity component of flexibility has been largely based on hypothetical, nonindividualized scenarios[31] or limited to situations generically defined as positive–negative in affect[32] or high–low in controllability[22,23]. The latter also confounded the evaluation of context with response to context—a crucial distinction underscored in existing literature[31]. Adopting a DIAMONDS assessment allows us to evaluate whether the ability to differentiate situational characteristics (that is, context sensitivity) is associated with affective outcomes. Similarly, the repertoire component of flexibility has diverse operationalizations, such as the number of strategies[33] or categorical variability[22], but neither definition considers individual differences in whether a strategy is effective. Using EMA design offers an opportunity to identify strategies that are effective specifically for each individual, thereby yielding a more idiosyncratic measure of repertoire. Finally, many studies on the feedback responsiveness component of flexibility have focused heavily on strategy switching[34,35] despite the conceptual emphasis on both strategy switching and strategy maintenance[36]. Intensive longitudinal designs, such as afforded by EMA, will allow for a sufficient number of observations per participant to capture both strategy maintenance and switching across situations.

In this article, the overarching goal is to test the flexibility sequence model[13] using a longitudinal EMA design with data from two distinct cultures, the United States and China. Specifically, we examine the associations between momentary measures of the flexibility sequence components (that is, context sensitivity, use of repertoire and feedback responsiveness) and affective outcomes (that is, total distress, depressed mood, anxious mood and perceived stress). In addition to refining measurement of flexibility components with comprehensive situation assessments, we investigate all flexibility components in the flexibility sequence model to elucidate whether they have independent benefits, which expands from research often examining flexibility components separately[22]. EMA captured ER, situational characteristics and psychological distress four times a day across 21 days. Each EMA captured the effectiveness of ER strategies initially adopted in response to the emotional situation and whether or not the participant chose to switch from their initial strategies.

Another important feature of our study is that we collected data from two highly distinct countries, taking into account the potential cross-cultural similarities and differences in the associations between ER flexibility and affective outcomes. Culture plays a pivotal role in shaping how individuals perceive, interpret and manage their emotions within specific sociocultural settings, as well as the function of ER[37,38]. Nonetheless, despite its crucial role, culture is often overlooked in the ER flexibility literature with samples primarily drawn from North America[39,40] and potentially limiting the generalizability of findings. Psychological theories developed based on Western, Educated, Industrialized, Rich, and Democratic (WEIRD) samples may not be universally applicable to other cultures[41]. Therefore, it becomes essential to incorporate samples from different cultures in ER flexibility research. For example, Chinese culture differs from American culture in its emphasis on collectivism, interpersonal harmony and emotional restraint, which may impact the use and function of ER flexibility. At the same time, because the flexibility concept emphasizes the situation–behavior fit, it transcends differences in the adaptiveness of individual ER strategies across cultures. It is plausible, therefore, that flexibility may be trans-culturally beneficial and offer a potential framework of examining healthy emotion regulation. Accordingly, our study seeks to examine the potential robustness and consistency of findings independently in the United States and China, as well as possible cross-cultural differences.

Accordingly, our study examined the robustness and consistency of findings independently in the United States and China, while identifying potential cross-cultural differences. In study 1 (United States), we developed proxy measures of flexibility components, tested their validity and examined their associations with momentary affective outcomes. In study 2 (China), we adopted the same measures and design to examine whether the findings generalized to a different cultural context. Guided by findings of study 1, which was conducted a few months before study 2, analyses and hypotheses for study 2 were preregistered.

Table 1 | Habitual ER strategy predicting momentary ER use

ER strategy	United States		China	
	ICC	*B* (s.e.)	ICC	*B* (s.e.)
Reappraisal	0.28	0.02 (0.02)	0.29	0.004 (0.02)
Suppression	0.24	0.05 (0.02)*	0.22	0.07 (0.02)**
Rumination	0.27	0.13 (0.04)***	0.24	0.19 (0.04)***
Worry	0.25	0.14 (0.03)***	0.15	0.07 (0.03)*
Plan	0.27	0.12 (0.03)**	0.29	0.15 (0.05)***
Positive refocus	0.27	0.10 (0.03)***	0.28	0.12 (0.05)*
Soothing	0.29	0.14 (0.02)***	0.18	0.06 (0.02)**
Perspective seeking	0.36	0.10 (0.03)***	0.29	0.08 (0.04)*

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Results

Study 1 (United States)

Comparing habitual ER with momentary ER. First, we used multi-level models (MLMs) to examine the relationship between habitual and momentary ER use. The intraclass correlation coefficients (ICCs) were all low, ranging from 0.24 to 0.36 across emotion regulation strategies (Table 1). In summary, habitual emotion regulation use was predictive of the momentary use of the respective strategy, $P < 0.05$, with the exception for reappraisal, $B = 0.2$, standard error of the mean (s.e.) 0.2 and $P = 0.40$. However, the magnitude of associations varies across strategies, suggesting that habitual ER is not a consistent or reliable proxy for momentary ER.

Predictor preparation/validation. We created a proxy for momentary context sensitivity by dividing the standard deviation of the nine situational characteristics by their mean (that is, coefficient of variation). This approach captured how much one can differentiate various situational characteristics in a given situation. We built a multilevel model predicting momentary context sensitivity with baseline measures of context sensitivity, repertoire and feedback. As expected, the momentary context sensitivity captured by the coefficient of variations score was associated with baseline context sensitivity, $B = 0.003$, s.e. 0.001 and $P = 0.002$, but not baseline expressive flexibility, an aspect of repertoire, $B = 0.0005$, s.e. 0.001 and $P = 0.56$, or baseline feedback responsiveness, $B = 0.0002$, s.e. 0.002 and $P = 0.89$. These results suggest that it is reasonable to use the coefficient of variations score as a proxy for momentary context sensitivity.

Additionally, we captured overall repertoire by counting the number of effective strategies for each participant across EMA situations. An effective strategy should have at least a small correlation ($r \geq 0.10$) with the effectiveness score. This overall repertoire measure was marginally associated with baseline expressive flexibility, $r = 0.13$ and $P = 0.09$, but not associated with baseline context sensitivity, $r = -0.01$ and $P = 0.86$, or baseline feedback, $r = 0.03$ and $P = 0.72$. We then obtained a momentary use of repertoire measure to reflect how many strategies one recruited from their overall repertoire in each situation. This momentary use of repertoire measure was used in subsequent MLMs.

Finally, we used the interaction between emotion regulation change and the effectiveness of initial strategies to test two aspects of feedback responsiveness. Specifically, we examined if individuals exhibited lower levels of momentary psychological distress in situations where they maintained effective strategies (that is, ER change is 0 when initial effectiveness was high) or switched from ineffective strategies (that is, ER change is 1 when initial effectiveness was low).

MLMs predicting total momentary distress. To test the flexibility sequence model, we built a multilevel model predicting total momentary distress after the regulation attempt (that is, the sum of momentary depressed mood, anxious mood and perceived stress in each EMA situation) with momentary context sensitivity, momentary use of repertoire and the interaction between ER change and initial effectiveness. For detailed results, please refer to Supplementary Material 2.

Consistent with theory suggesting the benefit of context sensitivity[42,43], there was a significant inverse association between momentary context sensitivity and total momentary distress, $B = -2.87$, s.e. 0.51 and $P < 0.001$, and between momentary use of repertoire and total momentary distress, $B = -0.49$ s.e. 0.11 and $P < 0.001$. The effectiveness of the initial strategies was also inversely associated with total distress after the regulation attempt, $B = -0.27$, s.e. 0.04 and $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.14$, s.e. 0.05 and $P = 0.002$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 standard deviation (s.d.) above the mean), participants who maintained their initial strategy choice (ER change of 0), compared with those who changed their strategies, reported lower total momentary distress after the regulation attempt, $B = 0.81$, s.e. 0.18 and $P < 0.001$. In contrast, participants who changed their strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) did not differ in total momentary distress compared with those who maintained their initial strategies, $B = 0.11$, s.e. 0.15, $P = 0.47$. This suggests that maintaining effective emotion regulation strategies was adaptive, while switching from ineffective emotion strategies was surprisingly not associated with psychological distress (Fig. 2).

MLMs for predicting momentary depression, anxiety and perceived stress. We further built MLMs predicting each momentary outcome (that is, depressed mood, anxious mood and perceived stress) separately. The results for momentary anxious mood and perceived stress were similar to the results for the combined variable—total momentary distress—in that maintaining effective strategies seemed adaptive.

When predicting momentary anxious mood, there was an inverse association between momentary context sensitivity and momentary anxious mood, $B = -1.44$, s.e. 0.23 and $P < 0.001$. Momentary use of repertoire was also inversely associated with momentary anxious mood, $B = -0.15$, s.e. 0.05 and $P = 0.003$. Additionally, increased effectiveness of the initial strategies was associated with decreased momentary anxious mood, $B = -0.11$, s.e. 0.02 and $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.04$, s.e. 0.02 and $P = 0.04$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d. above the mean), participants who maintained their ER strategies (ER change of 0) reported a lower momentary anxious mood compared with those who changed their strategies, $B = 0.38$, s.e. 0.08 and $P < 0.001$. In contrast, participants who switched their strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) did not differ in anxious mood compared with those who maintained their strategies, $B = 0.05$, s.e. 0.06 and $P = 0.43$.

When predicting momentary perceived stress, there was an inverse association between momentary context sensitivity and momentary perceived stress, $B = -1.07$, s.e. 0.20 and $P < 0.001$, and between momentary use of repertoire and momentary perceived stress, $B = -0.21$, s.e. 0.05 and $P < 0.001$. The effectiveness of the initial ER strategies was also inversely associated with momentary perceived stress, $B = -0.11$, s.e. 0.02 and $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.07$, s.e. 0.02 and $P < 0.001$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d. above the mean), participants who maintained their ER strategies (ER change of 0) reported lower momentary perceived stress compared with those who changed their strategies, $B = 0.39$, s.e. 0.08 and $P < 0.001$. In contrast, participants who switched their strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean)
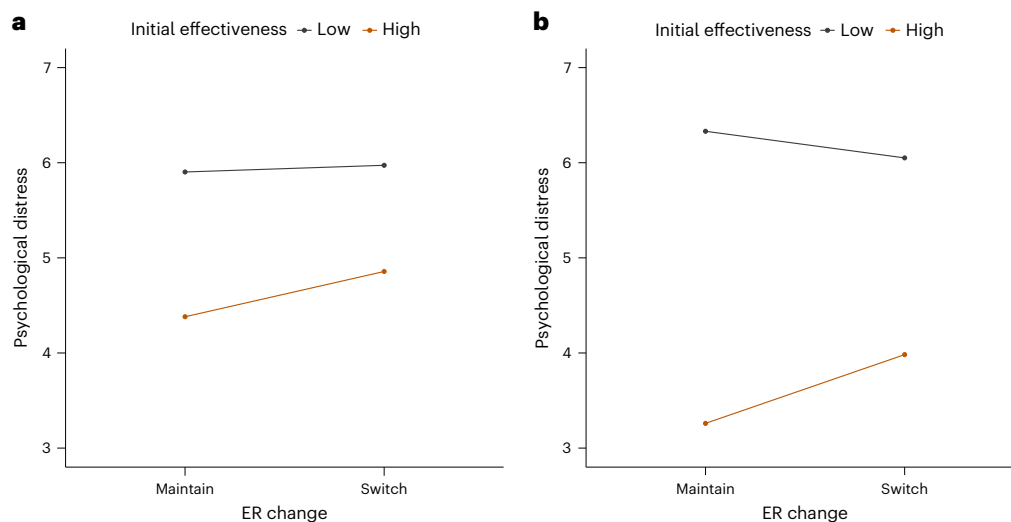
Fig. 2 | Association between emotion regulation change and psychological distress at low (−1 s.d.) and high (+1 s.d.) levels of initial effectiveness in both cultures. a, Association between emotion regulation change and psychological distress at low (−1 s.d.) and high (+1 s.d.) levels of initial effectiveness in study 1 (United States). **b**, Association between emotion regulation change and psychological distress at low (−1 s.d.) and high (+1 s.d.) levels of initial effectiveness in study 2 (China).

did not differ in perceived stress compared with those who maintained their strategies, $B = 0.03$, s.e. 0.07 and $P = 0.57$.

Contrary to the aforementioned results, the results for momentary depressed mood suggested that switching from ineffective strategies was adaptive. There was an inverse association between momentary context sensitivity and momentary depressed mood, $B = −0.38$, s.e. 0.16 and $P = 0.01$, and between momentary use of repertoire and momentary depressed mood, $B = −0.10$, s.e. 0.02 and $P < 0.001$. The effectiveness of the initial strategies was also inversely associated with momentary depressed mood, $B = −0.06$, s.e. 0.01 and $P < 0.001$. Finally, there was a marginally significant interaction between emotion regulation change and initial effectiveness, $B = 0.03$, s.e. 0.02 and $P = 0.05$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d. above the mean), participants who maintained their ER strategies (ER change of 0) did not differ in momentary depressed mood after the regulation attempt, compared with those who changed their ER strategies, $B = 0.05$, s.e. 0.06 and $P = 0.38$. In contrast, participants who switched their ER strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) reported lower momentary depressed mood following the regulation attempt compared with those who maintained their strategies, $B = −0.10$, s.e. 0.05 and $P = 0.04$.

Study 2 (China)
Comparing habitual ER with momentary ER. First, we used MLMs to examine the relationship between habitual and momentary ER use among the Chinese sample. Similar to the US sample, the ICCs were all low, ranging from 0.15 to 0.29 across emotion regulation strategies (Table 1). Again, habitual emotion regulation use was predictive of the momentary use of the respective strategy, $P < 0.05$, with the exception for reappraisal, $B = 0.004$, s.e. 0.2 and $P = 0.86$. Consistent with study 1, the magnitude of associations varies across strategies, suggesting that habitual ER is not a consistent or reliable proxy for ER in real time.

MLMs predicting total momentary distress. To test the flexibility model, we built a multilevel model predicting total momentary distress after the regulation attempt (that is, the sum of momentary depressed mood, anxious mood and perceived stress in each EMA situation) with momentary context sensitivity, momentary use of repertoire and the

interaction between ER change and initial effectiveness. For detailed results, please refer to Supplementary Material 2.

Consistent with theory suggesting the benefit of context sensitivity[42,43], there was a significant inverse association between momentary context sensitivity and total momentary distress, $B = −1.38$, s.e. 0.53 and $P = 0.009$, and between momentary use of repertoire and total momentary distress, $B = −0.40$, s.e. 0.10 and $P = 0.001$. The effectiveness of the initial strategies was also inversely associated with total distress after the regulation attempt, $B = −0.47$, s.e. 0.04, $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.23$, s.e. 0.03, $P < 0.001$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d. above the mean), participants who maintained their initial strategy choice (ER change of 0)), compared with those who changed their strategies, reported lower total momentary distress after the regulation attempt, $B = 0.89$, s.e. 0.13 and $P < 0.001$. In contrast, participants who changed their strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) reported lower total momentary distress compared with those who maintained their initial strategies, $B = −0.34$, s.e. 0.12 and $P = 0.004$. This suggests that both maintaining effective and switching from ineffective strategies were adaptive (Fig. 2).

MLMs for predicting momentary depression, anxiety and perceived stress. We further built MLMs predicting each momentary outcome (that is, depressed mood, anxious mood and perceived stress) separately. The results for momentary anxious mood and perceived stress were similar to the results from study 1 in that maintaining effective strategies seemed adaptive. However, switching from ineffective strategies seemed adaptive for both depressed mood and perceived stress.

When predicting momentary anxious mood, there was an inverse association between momentary context sensitivity and momentary anxious mood, $B = −0.68$, s.e. 0.21 and $P = 0.001$. Momentary use of repertoire was also inversely associated with momentary anxious mood, $B = −0.10$, s.e. 0.04 and $P = 0.009$. Additionally, increased effectiveness of the initial strategies was associated with decreased momentary anxious mood, $B = −0.19$, s.e. 0.02 $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.09$, s.e. 0.01 and $P < 0.001$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d.

above the mean), participants who maintained their ER strategies (ER change of 0) reported lower momentary anxious mood compared with those who changed their strategies, $B = 0.43$, s.e. 0.06 and $P < 0.001$. In contrast, participants who switched their strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) did not differ in anxious mood compared with those who maintained their strategies, $B = -0.07$, s.e. 0.05 and $P = 0.17$.

When predicting momentary perceived stress, there was an inverse association between momentary context sensitivity and momentary perceived stress, $B = -0.43$, s.e. 0.20 and $P = 0.03$, and between momentary use of repertoire and momentary perceived stress, $B = -0.15$, s.e. 0.04 and $P < 0.001$. The effectiveness of the initial ER strategies was also inversely associated with momentary perceived stress, $B = -0.16$, s.e. 0.02 and $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.08$, s.e. 0.01 and $P < 0.001$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d. above the mean), participants who maintained their ER strategies (ER change of 0) reported lower momentary perceived stress compared with those who changed their strategies, $B = 0.33$, s.e. 0.05 and $P < 0.001$. In contrast, participants who switched their strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) reported lower perceived stress compared with those who maintained their strategies, $B = -0.10$, s.e. 0.05 and $P = 0.04$, though the effect size was relatively small.

For momentary depressed mood, both maintaining effective strategies and switching from ineffective strategies seemed adaptive. Momentary context sensitivity was not associated with momentary depressed mood, $B = -0.26$, s.e. 0.17 and $P = 0.11$, but there was a significant inverse association between momentary use of repertoire and momentary depressed mood, $B = -0.13$, s.e. 0.03 and $P < 0.001$. The effectiveness of the initial strategies was also inversely associated with momentary depressed mood, $B = -0.13$, s.e. 0.01 and $P < 0.001$. Finally, there was a significant interaction between emotion regulation change and initial effectiveness, $B = 0.06$, s.e. 0.01 and $P < 0.001$. The simple slope analyses indicated that when the initial effectiveness was high (that is, 1 s.d. above the mean), participants who maintained their ER strategies (ER change of 0) reported lower momentary depressed mood after the regulation attempt, compared with those who changed their ER strategies, $B = 0.13$, s.e. 0.05 and $P = 0.006$. Additionally, participants who switched their ER strategies (ER change of 1) when the initial effectiveness was low (that is, 1 s.d. below the mean) reported lower momentary depressed mood following the regulation attempt compared with those who maintained their strategies, $B = -0.18$, s.e. 0.04 and $P < 0.001$.

Cross-cultural comparisons

First, we compared flexibility components between US and Chinese participants. US participants had higher momentary context sensitivity, $d = 0.32$ and $P < 0.01$, and higher momentary use of repertoire, $d = 0.68$ and $P < 0.001$. While we could not directly compare momentary feedback responsiveness (conceptualized as the interaction between strategy effectiveness and emotion regulation change) by cultures, we examined the interaction between culture and strategy effectiveness on emotion regulation change, which was significant, $B = -0.008$, s.e. 0.004 and $P = 0.03$. Specifically, Chinese participants were more likely than US participants to change strategies when the initial effectiveness was low.

Second, we conducted a series of MLMs to delineate cultural similarities and differences in how flexibility components were associated with momentary affective outcomes. Specifically, we introduced culture (China 1 and USA 0) as a cross-level moderator for the associations between flexibility components and momentary affective outcomes. For momentary context sensitivity, culture significantly moderated its associations with momentary total distress, $B = 1.53$, s.e. 0.73 and $P = 0.04$, momentary anxious mood, $B = 0.79$, s.e. 0.31 and $P = 0.01$,

and momentary perceived stress, $B = 0.66$, s.e. 0.28 and $P = 0.02$, but culture did not moderate its association with momentary depressed mood, $B = 0.12$, s.e. 0.23 and $P = 0.60$. Inspection of MLMs by cultures suggested that the effects of momentary context sensitivity were generally larger for US participants than Chinese participants. By contrast, culture did not moderate any of the associations between momentary use of repertoire and momentary affective outcomes, $P > 0.30$, suggesting similar effects across cultures. However, culture moderated the association between momentary feedback responsiveness and momentary anxious mood, $B = 0.05$, s.e. 0.02 and $P = 0.03$. Inspection of MLMs by cultures indicated that there was a significant difference in the effect size of switching from ineffective strategies on momentary anxious mood, but this difference was not meaningful since the effect was insignificant in both cultures. However, switching from ineffective strategies was significantly associated with momentary total distress and perceived stress among Chinese participants but not US participants, suggesting greater benefits of strategy switching in Chinese culture. The detailed descriptive statistics of variables by cultures are reported in Supplementary Material 3.

Discussion

ER flexibility has been conceptualized as a broad process that involves multiple, serially related componential abilities described as the flexibility sequence: context sensitivity, repertoire and feedback responsiveness[13]. In two independent, cross-cultural samples, the current investigation provided basic support for this model using a longitudinal EMA design. When predicting momentary emotion regulation with baseline trait emotion regulation, only reappraisal did not exhibit a significant predictive relationship between trait and momentary measures. This finding is somewhat intriguing, given the significant correlation observed between trait and momentary positive refocusing, a construct closely related to reappraisal. One possible explanation is that the situational context, including emotional valence, may have a more pronounced impact on the momentary use of reappraisal than other ER strategies. Future research is encouraged to explore various facets of reappraisal (for example, positive, negative and distancing reappraisal) across diverse situations, aiming to shed light on when, where and how individuals employ reappraisal. On the other hand, it is worth considering that because associations between trait and momentary strategies were all relatively small, the lack of a significant association for reappraisal may be spurious and have little practical meaning.

Our findings also provide evidence for the transcultural similarities in the adaptiveness of ER flexibility while suggesting some interesting differences. Overall, there were considerable cross-cultural similarities in the adaptiveness of flexibility components. In both cultures, momentary context sensitivity and use of repertoire were inversely associated with most momentary affective outcomes. Notably, trait repertoire did not predict momentary affective outcomes across both studies, suggesting that how one deploys their emotional repertoire in the moment, rather than their overall use of repertoire, plays a crucial role in momentary emotional outcomes. This underscores the importance of examining emotion regulation dynamics in daily contexts beyond simply measuring trait-level strategy use. Future research should explore the relationships between trait and state levels of repertoire use and various emotional outcomes, including momentary and trait affect and psychopathology. In both cultures, maintaining effective strategies was adaptive for momentary anxious mood, perceived stress and total distress, whereas switching from ineffective strategies was adaptive for momentary depressed mood. We did not observe any benefit of switching from ineffective strategies for anxiety in either study. One possible explanation could be that switching alone did not guarantee subsequent regulatory success. Individuals with heightened anxiety may switch from one set of ineffective strategies to another set of ineffective strategies (that is, 'busy coping'), which may not facilitate adaptation. On the contrary, depression has been

characterized by the tendency for affective states to be resistant to change[44], which may have contributed to the observed benefits of strategy switching for momentary depressed mood.

Comparing flexibility components by cultures, our findings suggest that US participants had higher momentary context sensitivity and use of repertoire but lower feedback responsiveness than Chinese participants. This suggests that there may be different cultural emphasis on components of flexibility. As for the associations between flexibility components and momentary affective outcomes, two notable cross-cultural differences emerged. First, context sensitivity had larger effect sizes for US participants compared with their Chinese counterparts, specifically in the association between momentary context sensitivity and depressed mood, which was significant for US participants but not for Chinese participants. Second, although switching from ineffective strategies was beneficial for reducing perceived stress and overall distress among Chinese participants, it did not yield the same benefits for Americans. Taken together, these findings suggest that context sensitivity is beneficial in both cultures, with more substantial effects observed in the US sample. On the other hand, strategy switching appears to be particularly advantageous for the Chinese sample, possibly reflecting the greater emphasis on adaptability influenced by collectivistic cultural norms in Eastern culture[45]. Interestingly, we did not observe greater levels and benefits of context sensitivity in the Chinese sample, implying that the pressure to adapt to situations may be more pronounced during the feedback stage but not necessarily during the evaluation stage. Future research should aim to replicate these cross-cultural findings using different approaches and different ways of conceptualizing flexibility components.

There were several limitations to our study. First, our study used a fixed schedule of EMAs and may not have adequately captured real-time emotion regulation. Additional research is needed to better understand the role of timescale as well as assessment intervals when assessing the benefits of ER flexibility. For future research, incorporating passive sensing data could provide temporally specific information as to when emotional situations occur, thus enabling more precise ER and situation assessments. Second, the current study did not explore racial differences in emotion regulation flexibility and their impact on affective outcomes due to limited sample sizes per racial group and insufficient statistical power. However, this remains an important area for future research, as previous studies[46,47] have highlighted differences in emotion regulation and their consequences for health across racial groups in the United States. Third, although we found the association between momentary flexibility and short-term mood outcomes, future research is needed to examine relations between momentary ER flexibility and long-term mental health outcomes. Fourth, self-selection bias is possible given that we recruit participants from social media platforms, which may have limited the sample representativeness and generalizability. Fifth, our study captured momentary context sensitivity by the relative variability in ratings of different situational characteristics, which as we noted may be limited. Future studies might further explore and standardize methods to assess participant reports of emotional situations by analyzing their free-text responses using human coding or natural language processing. Finally, the associations we observed in this study cannot be used to infer causality. Future research would benefit from additional experimental and intervention studies that seek to directly test participant's use of the flexibility sequence.

Despite these limitations, our study nonetheless potentially advanced ER flexibility research in several ways. First, we expanded the scope of this research by using an intensive longitudinal design to capture multiple components of emotion regulation flexibility and their sequential relationship. Previous studies had only examined the components of the flexibility sequence cross-sectionally[14] or in EMA studies that examined these components in separate models[22]. Second, our study bridged situational characteristics research in the social psychology literature[29] and ER flexibility in the clinical literature[13].

In doing so, we introduced an innovative way to study ER flexibility that extends beyond the relatively limited situational characteristics used in previous research—such as controllability or intensity[22,23]—by incorporating a more comprehensive assessment of situations. Third, we included independent samples from two distinct cultures, which helped reveal transcultural similarities and differences in the adaptiveness of ER flexibility.

Conclusions

Across two EMA studies on emotion regulation flexibility using US and Chinese samples, we found that increased momentary context sensitivity and use of repertoire were associated with reduced momentary distress, while results for feedback responsiveness were less consistent. Maintaining effective strategies was generally adaptive, whereas switching from ineffective strategies was adaptive for momentary depressed but not anxious mood. This study demonstrates transcultural similarities in ER flexibility's benefits while also highlighting some potential cross-cultural differences.

Methods

The research complies with all relevant ethical regulations. The institutional review board at Teachers College, Columbia University approved study 1 (22-218) and the Institutional Review Board at the Department of Psychology, Tsinghua University, approved study 2 (THU2022-27). All participants have provided informed consent before participation.

Study 1 (United States)

Data and participants. Participants were recruited from multiple social media platforms (for example, Facebook, Instagram and Reddit). The sample size was determined based on the *N* required for accurate statistical estimates in multilevel modeling[48] and the sample size considerations for the larger study. A total of 173 US participants were enrolled in the study. A total of 15 participants left the study before or during the EMA phase of study (8 withdrew during the orientation meeting and 7 withdrew during EMA), leaving 158 participants in our final analyses. Participants were compensated US$40 if they completed 80% of the daily surveys and US$60 if they completed 95% of the daily surveys. Participants withdrew during EMA mainly because they failed quality checks of emotional situations and careless response and could not reach above 80% to obtain compensation. Those who stayed in the study completed 77 out of 84 (92.05%) daily surveys on average. Most of the participants identified as women (36 men, 116 women and 6 nonbinary or nonconforming individuals). Participants ranged from 18 to 72 years in age (*M* = 35.97 and s.d. 12.45) and were racially diverse, with 49.37% Caucasian American, 13.29% Black or African American, 27.22% Asian American and 2.53% American Indian, Alaska Native or Native Hawaiian. In the sample, 10.76% identified as Hispanic or Latinx. This study followed the reporting guidelines of the adapted Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for reporting EMA studies (CREMAS)[49].

Measures. *Baseline and exit survey.* Participants completed a baseline and an exit survey before and after the EMA phase, respectively. Both surveys were distributed through the Qualtrics platform. Measures of the baseline and exit surveys were identical, including demographics, components of flexibility (that is, context sensitivity, repertoire and feedback responsiveness), habitual use of emotion regulation and symptoms of depression and anxiety. The analysis involved in this paper included only components of flexibility and habitual emotion regulation. For detail of measures and validation, please refer to Supplementary Material 1.

EMA measures. Each participant completed an orientation meeting with one of 14 trained graduate research assistants the day before their first EMA survey. During the orientation meeting, the research assistant

explained the EMA procedure and instructed the participant to complete a practice EMA survey. This allowed participants an opportunity to ask questions about the EMA procedure. During the EMA phase, participants were prompted by Metricwire, a mobile app designed for experience sampling, to complete EMA surveys four times per day at approximately 12:00, 15:00, 18:00 and 21:00 over the course of 21 days (that is, 84 EMA surveys in total). Once they received the prompt, they had 90 min to respond. After that, the EMA survey expired and was marked as missing. All 84 EMA surveys were identical, assessing the most emotional situation in the past three hours, followed by measures of perceived situational characteristics, emotion regulation strategies, effectiveness of emotion regulation strategies, whether participants changed their initial emotion regulation strategies and momentary psychological distress following the regulation attempt. All questions were detailed below, in the order of how they were presented in each EMA survey.

The emotional situation: each EMA survey started with asking the participant to recall the most emotionally salient situation in the past 3 h. Similar to previous studies[24,29], participants were asked to write a response covering the following information: Where were you? Who was with you? What were you (and others) doing? What was happening? Unlike previous studies, however, we did not ask participant to indicate when the situation occurred to avoid redundancy since the prompt already restricted the time frame to the past 3 h.

Perceived situational characteristics: we used ultrabrief measures for the situational eight DIAMONDS domains[29] to assess perceived situational characteristics. We included an additional item to assess controllability, as recent studies highlighted its important role in the adaptiveness of emotion regulation strategies[11]. Participants rated how much each of these nine characteristics applied to the most emotional situation they wrote on seven-point scale from 1 (not at all) to 7 (totally). Duty was measured by 'work has to be done'. Intellect was measured by 'deep thinking is required'. Adversity was measured by 'someone is being threatened, blamed or criticized'. Mating was measured by 'the situation is romantically or sexually charged'. The original item was 'potential romantic partners are present', which may limit the scope of dimension. We therefore chose an item from S8* ('situation is sexually charged'), a DIAMONDS measure with three items per dimension. Following consultation with the lead author of the ultrabrief measure (J.F. Rauthmann, personal communication, 1 August 2022), we added 'romantically' to make sure the item remains consistent with the scope of the mating dimension. Positivity was measured by 'situation is enjoyable'. Negativity was measured by 'situation includes negative feelings (for example, stress, anxiety or guilt)'. Deception was measured by 'someone is being deceived'. Sociality was measured by 'social interaction is possible or required'. Controllability was measured by 'I have control over the situation'.

Initial momentary emotion regulation strategies: participants rated whether they used a series of emotion regulation strategies as 0 (no) or 1 (yes) on the basis of their initial, knee-jerk response to the situation. Participants were instructed to select all strategies they utilized in the situation. These strategies included cognitive reappraisal (that is, I changed how I thought about the event), expressive suppression (that is, I made sure to hide how I feel), rumination (that is, I repeatedly thought about the event and could not stop), worry (that is, I worried about what may happen), distraction (that is, I did something else to take my mind off it), problem solving (that is, I tried to solve problems or resolve the events), savoring (that is, I took time to savor or enjoy what happened), planning (that is, I made plans for the next steps), positive refocusing (that is, I focused on the positive aspect of the event), soothing (that is, I looked to others for comfort) and perspective seeking (that is, I tried to find out what others would do if they were in my situation).

Effectiveness of initial ER strategies: after indicating their initial emotion regulation strategies, participants were asked to rate the effectiveness of the ER strategies they used on a 5-point scale from 1 (not at all) to 5 (extremely). Specifically, they were asked three questions: Did your initial response decrease distress, sadness or anxiety? Did your initial response enhance pleasure, happiness or calmness? Did your initial response facilitate problem solving? These three items were summed to reflect the effectiveness of initial repertoire ($\omega_{\text{within-person}} = 0.70$ and $\omega_{\text{between-person}} = 0.88$).

Emotion regulation change: after rating the effectiveness of their initial ER strategies, participants were asked to indicate whether they changed their initial response to the situation, on a binary scale of either 0 (no) or 1 (yes).

Updated/hypothetical momentary ER strategies and their effectiveness: depending on whether the participant changed or maintained their initial emotion regulation strategies, they were asked to indicate either their updated emotion regulation strategies (if they changed) or hypothetical emotion regulation strategies they would have used next (if they maintained). We included the hypothetical questions for participants who maintained their initial ER strategies to balance the length of EMA surveys and to reduce the likelihood that participants might indicate no strategy change so that they could end the EMA session more quickly. After indicating their updated or hypothetical momentary emotion regulation strategies, participants rerated the effectiveness of these strategies. The items assessing updated/hypothetical emotion regulation strategies and their effectiveness were identical to the questions following initial ER strategy selection.

Measures of momentary distress. The EMA survey ended with questions regarding momentary distress in the past 3 h. Similar to previous studies[50], total distress was assessed by six items selected from the Depression, Anxiety, and Stress Scale[51] and the Generalized Anxiety Disorder Scale[52]. Participants rated these on a five-point scale from 1 (not at all) to 5 (extremely). Two items captured momentary perceived stress ($\omega_{\text{within-person}} = 0.73$ and $\omega_{\text{between-person}} = 0.92$): 'I found it difficult to relax' and 'I felt irritable'. Two items assessed momentary anxious mood ($\omega_{\text{within-person}} = 0.82$ and $\omega_{\text{between-person}} = 0.96$): 'I was worried about different things' and 'I felt nervous, anxious or on edge'. Two items assessed momentary depressed mood ($\omega_{\text{within-person}} = 0.78$ and $\omega_{\text{between-person}} = 0.98$): 'I felt that I had nothing to look forward' and 'I couldn't seem to experience any positive feeling at all'. In addition to calculating scores of momentary perceived stress, anxious mood and depressed mood by summing up their corresponding items, we summed all six items to reflect total momentary distress ($\omega_{\text{within-person}} = 0.87$ and $\omega_{\text{between-person}} = 0.95$).

Statistical analysis. R Version 4.2.1 (ref. 53) and the nlme[54], lme4[55] and reghelper[56] packages were used for our analyses. The sample size was determined based on the *N* required for accurate statistical estimates in multilevel modeling[48] and the sample size considerations for the larger study. First, we reported ICCs for each momentary ER strategy to illustrate how much variances were within-person. Then, we built MLMs to predict momentary reappraisal, suppression, rumination, worry, planning, positive refocusing, soothing and perspective seeking with their respective habitual measures. We did not have habitual measures for distraction, problem solving and savoring, given the lack of well-validated measures for these strategies. Therefore, these three strategies were not included in this analysis. This analysis allowed us to assess how much momentary emotion regulation was associated with their habitual counterparts.

Second, but more crucial for the current investigation, we tested the flexibility sequence model by examining whether momentary measures of context sensitivity, use of repertoire and feedback responsiveness would be associated with total momentary distress and its three subdimensions (that is, depressed mood, anxious mood and perceived stress) measured after the regulation attempt.

We estimated a proxy for momentary context sensitivity by obtaining the coefficient of variation of the nine situational characteristics

(that is, DIAMONDS and controllability) for each person in each situation, which captures how well individuals differentiated among different situational characteristics in a given situation (see equation (1) below). For each situation, participants rated each of the nine situational characteristics from 1 to 7. We calculated the standard deviation for the nine ratings for each participant in each situation, which captured the variability of the ratings. Next, we divided each standard deviation by the mean of the nine ratings for that situation, which serves to adjust the variability of the ratings for overall reporting tendency. To further validate whether this score could serve as a proxy measure of momentary context sensitivity, we built a MLM with momentary context sensitivity as the dependent variable, and baseline measures of context sensitivity, repertoire, and feedback responsiveness as predictors. The analyses were conducted with random intercepts.

$$\text{Momentary context sensitivity} = \frac{\text{s.d.(nine situational characteristics)}}{\text{mean(nine situational characteristics)}}$$

We estimated two repertoire variables: overall repertoire, a between-person variable, and momentary use of repertoire, a within-person variable. We estimated the overall repertoire score for each participant by summing the number of effective ER strategies a participant used over the course of the entire EMA study. An ER strategy was considered effective for a participant, when across all EMA situations, the correlation between using this strategy and strategy effectiveness (that is, the sum of increasing positive affect, decreasing negative affect and facilitating problem solving) was positive and at least small in size (that is, $r > 0.10$[57]). To estimate the validity of the overall repertoire score, we examined its correlation with baseline context sensitivity, expressive flexibility (an aspect of repertoire) and feedback responsiveness. We estimated the momentary use of repertoire as each participant's use of strategies from their overall repertoire in each situation. For example, if a participant had four ER strategies (for example, reappraisal, distraction, problem solving and savoring) exhibiting positive correlations with strategy effectiveness at above 0.10, their overall repertoire would be 4. In a given situation reported in an EMA survey, if the participant used two out of these four effective ER strategies (for example, reappraisal and problem solving), their momentary use of repertoire in that situation would be 2.

We used the interaction between ER change and initial effectiveness to assess the adaptiveness of momentary feedback responsiveness. In specific, we hypothesized that individuals would report lower levels of momentary distress in situations where they maintained effective strategies (that is, ER change of 0 when initial effectiveness was high) or switched from ineffective strategies (that is, ER change of 1 when initial effectiveness was low).

Finally, we built a MLM predicting momentary measures of total distress and as well as its three component measures (that is, depressed mood, anxious mood and perceived stress) by momentary measures of context sensitivity, use of repertoire, effectiveness of initial ER strategies, ER change and the interaction between ER change and initial effectiveness. At level 1, predictors were person-centered to assess within-person deviations from the participant's mean. At level 2, they were grand-mean centered to evaluate and control for between-person effects[58,59].

Study 2 (China)
Data and participants. Participants were recruited from multiple social media platforms (for example, Weibo, WeChat and Xiaohongshu). A total of 167 participants were enrolled. A total of 23 participants left the study before or during the EMA phase of study (10 withdrew during the orientation meeting and 13 withdrew during EMA), leaving 144 participants in our final analyses. Participants were compensated 220 renminbi if they completed 80% of the daily surveys and 300 renminbi if they completed 95% of the daily surveys. Participants withdrew during

EMA mainly because they failed quality checks of emotional situations and careless response and could not reach above 80% to obtain compensation. Those who remained in the study completed 78.95 out of 84 (93.99%) daily surveys on average. Most of the participants identified as women (55 men, 88 women and 1 nonbinary or nonconforming individual). Participants ranged from 18 to 55 in age ($M = 29.37$ and s.d. 8.50). This study followed the reporting guidelines of the adapted STROBE CREMAS[49].

Measures. *Baseline and exit survey.* Participants completed a baseline and an exit survey before and after the EMA phase of study. Both surveys were distributed through the Questionnaire Star survey collection platform (https://www.wjx.cn). Measures of the baseline and exit surveys were identical, including demographics, components of flexibility (except for context sensitivity due to lack of such measure in Chinese), habitual use of emotion regulation strategies and symptoms of depression and anxiety. Measures of flexibility components, habitual use of emotion and symptoms of depression and anxiety were validated Chinese versions of the same measures used in study 1. For detail of measures and validation, please refer to Supplementary Material 1.

EMA measures. Each participant completed an orientation meeting with one of ten trained graduate research assistants the day before the first EMA survey. During the EMA phase, participants were prompted by Ding Talk (https://www.dingtalk.com/en), a Chinese mobile app suitable for experience sampling, to complete EMA surveys four times per day at approximately 12:00, 15:00, 18:00 and 12:00 over the course of 21 days (that is, 84 EMA surveys in total). Once they received the prompt, they had 90 min to respond. After that, the EMA survey expired and was marked as missing. As in study 1, all 84 EMA surveys were identical, assessing the most emotional situation in the past 3 h, followed by measures of perceived situational characteristics, ER strategies, effectiveness of ER strategies, whether participants changed their initial ER strategies and levels of momentary psychological distress following the regulation attempt. Unless specified otherwise, the wordings of EMA measures were identical to measures used in study 1 and were translated from English to Chinese by three graduate psychology students following the procedures of standard translation and back translation (Brislin, 1970). For detail of measures and validation, please refer to Supplementary Material 1.

Statistical analysis. The analytic plan in study 2 was preregistered before data analysis and the completion of data collection[60]. As in study 1, analyses were implemented in R Version 4.2.1 (ref. [53]) and the nlme[54], lme4[55] and reghelper[56] packages, and the sample size was determined based on the N required for accurate statistical estimates in multilevel modeling[48] and the sample size considerations for the larger study. Following advice from reviewers, we included additional, unplanned cross-cultural comparisons, reported under 'Cross-cultural comparisons' section in Results.

Reporting summary
Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability
The data for the present study are still being analyzed by the research team for additional publications separate from the focus of this paper. However, data can be made available upon reasonable request by contacting Mark Shuquan Chen at sc4173@tc.columbia.edu.

Code availability
The script used to generate the study findings is publicly available on the Open Science Framework at https://osf.io/gbmvx/.

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Author contributions

M.S.C. and G.A.B. conceptualized the work. M.S.C., K.B. and X.H. wrote the initial draft. M.S.C. and G.A.B. designed the methodology. M.S.C. and K.B. performed formal analysis and investigation. P.S., K.B., X.H. and M.S.C. performed data curation. X.H. and K.B. performed data visualization. G.A.B. and P.S. provided critical feedback for the original paper and revisions. M.S.C., G.A.B. and P.S. acquired funding and supervised the work.

Inclusion and ethics

The institutional review board at Teachers College, Columbia University approved Study 1 (22-218) and the institutional review board at the Department of Psychology, Tsinghua University approved Study 2 (THU2022-27). All participants have provided informed consent before participation.

Competing interests

The authors declare no competing interests.

Additional information

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☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
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Software and code

Policy information about availability of computer code

Data collection	The data for Study 1 (US) were collected via Qualtrics (baseline survey) and Metricwire (daily surveys). The data for Study 2 (China) were collected via Questionnaire Star (baseline survey) and Ding Talk 2023 (daily surveys).
Data analysis	Data analysis was performed in R Version 4.2.1 and the nlme, lme4, and reghelper packages. The script used to generate the study findings is publicly available at https://osf.io/gbmvx/.

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The data for the present study are still being analyzed by the research team for additional publications separate from the focus of this manuscript. However, data can be made available upon reasonable request by contacting Mark Shuquan Chen at sc4173@tc.columbia.edu.

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	We only used gender, which was based on participants' self-report. We haven't performed any gender-based analysis.
Reporting on race, ethnicity, or other socially relevant groupings	In Study 1, we asked participant to report "What race do you consider yourself to be? Select one or more of the following." The options included "Asian," "Black or African American," "Latino or Latina," "Native Hawaiian or Other Pacific Islander," "White," and "Check here if do not wish to provide this information." We reported race breakdown in the manuscript but did not examine race as a predictor or covariate in the manuscript. In Study 2, race was not applicable as it was a 100% local Chinese sample.
Population characteristics	See above.
Recruitment	US Participants were recruited from multiple social media platforms (e.g., Facebook, Instagram, Reddit); Chinese articipants were recruited from multiple social media platforms (e.g., Weibo, WeChat, Xiaohongshu). The recruitment from social media may result in self-selection bias and limit generalizability of the study findings.
Ethics oversight	The institutional review board at Teachers College, Columbia University approved Study 1 (22-218) and the institutional review board at the Department of Psychology, Tsinghua University approved Study 2 (THU2022-27). All participants have provided informed consent prior to participation.

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences   ☒ Behavioural & social sciences   ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Quantitative Ecological Momentary Assessment Design
Research sample	Study 1: Participants were recruited from multiple social media platforms (e.g., Facebook, Instagram, Reddit). A total of 173 USA participants were enrolled in the study. Fifteen participants left the study before or during the EMA phase of study (eight withdrew during the orientation meeting, seven withdrew during EMA), leaving 158 participants in our final analyses. Most of the participants identified as women (36 men, 116 women, and 6 non-binary or non-conforming individuals). Participants ranged from 18 to 72 in age (M = 35.97, SD = 12.45) and were racially diverse, with 49.37% of Caucasian American, 13.29% Black or African American, 27.22% Asian American, and 2.53% American Indian, Alaska Native, or Native Hawaiian. In the sample, 10.76% identified as Hispanic or Latinx. This sample is representative of US adults, and we chose this sample to increase representation of diverse racial groups and age range. Study 2: Participants were recruited from multiple social media platforms (e.g., Weibo, WeChat, Xiaohongshu). A total of 167 participants were enrolled. Twenty-three participants left the study before or during the EMA phase of study (ten withdrew during the orientation meeting, thirteen withdrew during EMA), leaving 144 participants in our final analyses. Most of the participants identified as women (55 men, 88 women, and one non-binary or non-conforming individual). Participants ranged from 18 to 55 in age (M = 29.37, SD = 8.50). This sample is representative of Chinese adults, and we chose this sample to increase representation of diverse age range.
Sampling strategy	Sampling strategy: In both studies, we adopted snowball and convenience sampling method. Additionally, we diversified our samples by posting on various social medias (e.g., Facebook ad, Reddit, Twitter, Linkedin in US for Study 1, Weibo, Wechat, and Redbook in China for Study 2). Sample size: The sample size was determined based on the N required for accurate statistical estimates in multilevel modeling (Mass & Hox, 2005) and the sample size considerations for the larger study.
Data collection	Participants completed baseline and daily surveys via their smartphone in their naturalistic environments, in the absence of the researchers.
Timing	Study 1: 10/7/2022-3/25/2023 Study 2: 11/20/2022-6/6/2023
Data exclusions	Study 1: A total of 173 USA participants were enrolled in the study. Fifteen participants left the study before or during the EMA phase of study (eight withdrew during the orientation meeting, seven withdrew during EMA), leaving 158 participants in our final analyses.

Non-participation	Study 2: A total of 167 participants were enrolled. Twenty-three participants left the study before or during the EMA phase of study (ten withdrew during the orientation meeting, thirteen withdrew during EMA), leaving 144 participants in our final analyses.
	Study 1: Fifteen participants left the study before or during the EMA phase of study (eight withdrew during the orientation meeting, seven withdrew during EMA).
	Study 2: Twenty-three participants left the study before or during the EMA phase of study (ten withdrew during the orientation meeting, thirteen withdrew during EMA).
Randomization	Participants were not allocated into experimental groups and there was no randomization as this was not an experimental study.

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern
☒	☐ Plants

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging