



Daily changes in state emotion regulation abilities predict positive and negative affect

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ABSTRACT

Emotion regulation (ER) abilities involve the capacity to manage the onset and course of emotions in service of situational goals, which facilitates affective changes dependent upon the contextual parameters. Despite the importance of ER abilities to psychopathology, understanding ER abilities across days, and how daily fluctuations in ER abilities relate to mood, is limited. This study examined the role of state ER in predicting positive and negative affect using a daily diary design (2812 daily surveys). Participants differed in within-individual variability for each domain of perceived state ER, and within- and between-individual fluctuations in perceived ER abilities predicted positive and negative affect. Findings support ER theory, given the importance of contextual, momentary changes in informing theoretical ER models. Implications for momentary assessment and intervention are discussed, focusing on contextual behavioral science.

Emotion regulation (ER) involves the awareness, acceptance, and understanding of emotions, and the ability to modulate emotions (Gratz & Roemer, 2004). The process and abilities models elaborate on approaches to ER, with the former (Gross, 1998) theorizing that individuals upregulate or downregulate emotions using antecedent- and response-focused strategies (Gross et al., 2006; McRae & Gross, 2020). The abilities model delineates predispositions to acknowledging and accepting emotional experiences and managing emotional activation, in line with situational goals (Gratz & Roemer, 2004). ER difficulties underlie psychological disorders (Aldao et al., 2010), which are characterized by psychological inflexibility in response to contextual changes (Hayes et al., 2011; Levin et al., 2014). In contrast, effective ER (i.e., modulating an emotional experience to yield a desired outcome; Gratz & Roemer, 2004), including flexible application of ER strategies, is a core process in promoting well-being (Aldao & Plate, 2018).

Critical to effective ER is consideration of the context in which emotions arise, as aspects of context (e.g., interpersonal experiences) dictate whether a strategy is adaptive or maladaptive (Gratz & Roemer, 2004; Gross, 2001; Lavender et al., 2017). Context has a critical role in shaping ER strategies (Aldao, 2013), and the significance of contextual

shifts in emotional experiences is echoed in functional contextual models of behavior change emphasizing the importance of understanding context to predict and influence behavior (Feliu-Soler et al., 2018; Hayes et al., 2011; Hayes & Hofmann, 2018). Variable use of ER strategies in line with environmental changes is posited to promote behavioral flexibility and improve mental health (Aldao, 2013; Palm Reed et al., 2018); however, limited empirical work has evaluated contextual factors influencing changes in ER (Aldao, 2013).

Consistent with models of ER and contextual behavioral science (Carl et al., 2013; Gratz & Roemer, 2004; Hayes et al., 2011; Jislin-Goldberg et al., 2012), difficulty regulating emotions could promote psychological inflexibility and psychopathology, while effective and situationally relevant use of ER may promote positive emotionality and psychological flexibility (Kashdan & Rottenberg, 2010) and reduce negative affect (Gratz & Roemer, 2004). Identification of antecedents and consequences of fluctuations in ER is critical for informing ER theory, idiographic interventions (Colombo et al., 2020; Pavlaci & Young, 2020; Hayes & Hofmann, 2018), and an understanding of how regulation varies across individuals. Although relationships between daily ER strategies and affective states have been established (Benson et al., 2019; Blanke et al.,

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2020; Brans et al., 2013; Brockman et al., 2017; Dixon-Gordon et al., 2021; Wenzel et al., 2021), there are fewer studies examining daily associations between perceived ER abilities and well-being (i.e., pleasant affect, negative affect, and life satisfaction; Diener et al., 1999) – despite the importance of contextual shifts in promoting changes in ER, psychological flexibility, and well-being (Aldao, 2013; Hayes et al., 2011).

Though ER is linked with the context in which it occurs, research on ER abilities has emphasized trait ER. However, studies have begun investigating the role of perceived state-based regulatory abilities (Lavender et al., 2017). The State Difficulties in Emotion Regulation Scale (S-DERS; Lavender et al., 2017) addresses limitations of trait ER by measuring perceived state-based ER abilities; yet, the initial study and subsequent work have only assessed state ER in cross-sectional or experimental designs (Eshelman et al., 2022; Lavender et al., 2017; Neilson et al., 2022). Albeit useful for measuring state ER and examining between-individual differences, little research has investigated its confluence with affect across repeated administration. An examination of the relative contributions of individual (Kurz et al., 2019) and between-person changes in perceived ER abilities in predicting daily affect is necessary for advancing theoretical models of ER and contextual behavioral science. Regarding the latter, given the conceptual overlap between domains of ER abilities and components of the psychological flexibility model (e.g., awareness and clarity compared to present moment awareness; modulation compared to experiential avoidance), associations between affective states and behavioral outcomes (Mun et al., 2015), and the relevance of assessment of within-individual variability to idiographic interventions (Hofmann & Hayes, 2018), an understanding of the relationships between daily ER abilities and mood states is essential.

Accordingly, we examined individual and between-individual fluctuations in perceived state ER abilities over time, hypothesizing that individual perceived ER scores would vary across 21 days. Second, we examined whether within- and between-individual changes in state ER predicted positive and negative affect, controlling for time given variability in completion times (Finkelstein-Fox, Pavlacic, Buchanan, Schulenberg, & Park, 2020) and the opposite emotion (Larsen et al., 2017). It was hypothesized that within- and between-individual increases in facets of emotion dysregulation would negatively predict positive affect and positively predict negative affect.

1. Method

1.1. Participants

Participants were 161 undergraduate students ($M_{age} = 19.08$, $SD_{age} = 3.45$) in the southeastern United States recruited from an online university study pool and social media. Most identified as white (80.75%), female (70.19%), and non-Latinx (93.17%), while 10.56% identified as Black/African American. Participants were recruited as part of a larger study examining the effectiveness of a mindfulness ecological momentary intervention (EMI); there were no exclusion criteria. Per the Depression Anxiety Stress Scale – 21 (Lovibond & Lovibond, 1995), the 160 participants providing these data were within normal levels for depression ($M = 8.51$, $SD = 8.39$) and stress ($M = 12.58$, $SD = 8.12$). Anxiety was mild ($M = 8.88$, $SD = 7.57$). The university's Institutional Review Board approved the study protocol, and consent was obtained.

1.2. Power

An *a priori* power analysis was conducted to determine the number of participants necessary based on the original EMI, hypothesizing a small effect size difference between groups given the proposed intervention, and a medium change in positive affect scores across time. Simulations generated power at different sample sizes; a sample size achieving approximately 90% power was selected. Power was simulated using a

multilevel model at 0.88 for 75 participants per group, and average power when simulating 70 to 80 was 0.86. An R script for simulations is at https://osf.io/r8qxn/?view_only=de3265fb18bd4824b177070552a1030b.

1.3. Procedure

The original study randomized participants to either an EMI condition or an ecological momentary assessment condition, where participants completed daily surveys for 21 days regardless of assignment. Group assignment did not facilitate changes in ER. Surveys were sent to smartphones daily at 5:00 p.m., and participants were instructed to complete the survey by 10:00 a.m. the following day.

1.4. Measures

1.4.1. Demographics

Participants completed a demographics questionnaire prior to randomization.

1.4.2. Daily measures

1.4.2.1. S-DERS. The State Difficulties in Emotion Regulation Scale (S-DERS; Lavender et al., 2017) is a 21-item measure assessing perceived ER abilities in the moment (i.e., nonacceptance, modulate, awareness, and clarity) and uses a 5-point Likert-type scale. Scores are summed, with higher subscale scores indicative of greater ER difficulties. The S-DERS was designed for repeated administrations (Lavender et al., 2017). Participants were prompted to indicate how each item applied to emotions 'right now.' The S-DERS yields strong psychometric properties (Lavender et al., 2017). When calculating internal consistency at the first daily survey, alpha was excellent (.90).

1.4.2.2. PANAS. The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) is a 20-item measure of domains of positive and negative affect using a 5-point Likert-type scale. Scores are summed for each subscale, with higher scores indicative of increased daily affect. Participants reported their affect 'right now, that is, at the present moment.' The PANAS has strong psychometric support (Watson et al., 1988). Alpha was excellent for positive affect (.91) and good for daily negative affect (.87) at time 1.

1.5. Data-analytic plan

1.5.1. Intraclass correlation coefficients

Intraclass correlation coefficients (ICCs) were calculated with a random intercept model (i.e., nesting daily scores within individuals) to determine the amount of variability accounted for at the within-individual level (i.e., daily scores) vs. the between-person level (i.e., differences between participants). Below, within-person scores refer to daily scores, whereas between-person scores refer to overall scores.

1.5.2. Multilevel modeling

Multilevel modeling (MLM) was used to examine within- and between-person changes over time for domains of ER. Analyses were conducted using the *lmerTest* (Kuznetsova et al., 2017), *sjstats* (Lüdtke, 2021), *nlme* (Pinheiro et al., 2017), and *MuMIn* (Barton, 2018) R packages. Within-person predictor variables were centered at 0, with between-person scores reflecting average scores across participants (Bolger & Laurenceau, 2013). By centering each participant's scores across the study at 0, we examined how daily changes in ER within individuals predict their own changes in positive and negative affect across time. Between-person variables model a single score, or a participant's overall mean. For example, if one participant had daily scores of 0, 5, and 10, their score in between-person analyses would be 5 (the

mean), while within-individual mean scores would be centered at 0. Scores of 0 and 10, then, would be represented as –5 and 5 (five points below and above the mean).

Using Field et al. (2012) guidelines, the MLM was built gradually, with model fit assessed at each step using a chi-square test and log-likelihood values to compare models. First, random intercept models were compared to fixed intercept models. Given the hierarchical data structure (i.e., daily scores nested within participants), differences in average responding were accounted for. Fixed intercept models assume minimal outcome variability across participants, while random intercept models allow for outcome variability. When comparing random intercept models to fixed intercept models, the random intercept of participant demonstrated better fit for positive and negative affect ($p < .001$). This result indicates that participants differed in their overall levels of reported positive and negative affect.

Participants were able to complete the daily surveys at their leisure; therefore, we controlled for completion time differences (time) by calculating the time in days since each participant’s first completed survey. Next, a random slope and fixed effect of cubic time were examined. This step was based on visual inspection of variability across the study and separate MLMs comparing the linear effects of time to quadratic and cubic effects (Field et al., 2012). A random slope of time allows participant slopes to vary, as participants might have different changes across 21 days. The cubic component models a cubic term, wherein participant slopes may fluctuate up and down across the study. Addition of a random slope of cubic time was significant for both positive and negative affect models ($p < .001$).

S-DERS predictors (i.e., within- and between-person nonacceptance, within- and between-person modulate, within- and between-person awareness, and within- and between-person clarity) were entered next, including parameters from prior steps. The final model included a random intercept of participant, a random slope of cubic time, and fixed effects of cubic time, within- and between-person negative affect in positive affect models and vice versa for negative affect models (given associations between positive and negative affect; Larsen et al., 2017), as well as within- and between-person effects for each domain of perceived ER (S-DERS subscales).

2. Results

2.1. Daily surveys

After screening data (e.g., failing an attention check, missingness), 160 individuals completed 2812 surveys ($M_{surveys} = 17.58$, $SD_{surveys} = 5.08$).

Table 1
Domains of emotion regulation abilities predict positive affect and negative affect.

| Predictor | Outcome: Positive Affect | | | | | Outcome: Negative Affect | | | | | |
|-----------------------------------|--------------------------|-------------------|-------------|--------------|------------------|--------------------------|--------------|-------------|-------------|--------------|------------------|
| | b | SE | df | t | p | b | SE | df | t | p | |
| Intercept | 40.17 | 2.39 | 2646 | 16.82 | < .001 | 2.14 | 1.47 | 2646 | 1.46 | .144 | |
| Cubic Time | –0.0003 | < 0.001 | 2646 | –4.85 | < .001 | –0.000008 | <.001 | 2646 | –0.23 | .818 | |
| Negative Affect & Positive Affect | Between | 0.21 | 0.20 | 154 | 1.06 | .290 | 0.03 | 0.03 | 154 | 1.13 | .262 |
| | Within | –0.09 | 0.03 | 2646 | –2.95 | .003 | –0.03 | 0.01 | 2646 | –2.85 | .005 |
| Nonacceptance | Between | 0.09 | 0.33 | 154 | 0.27 | .785 | 0.75 | 0.11 | 154 | 6.59 | < .001 |
| | Within | –0.06 | 0.05 | 2646 | –1.17 | .244 | 0.51 | 0.03 | 2646 | 17.93 | < .001 |
| Modulate | Between | –0.52 | 0.25 | 154 | –2.05 | .042 | 0.25 | 0.10 | 154 | 2.60 | .010 |
| | Within | –0.31 | 0.05 | 2646 | –6.30 | < .001 | 0.44 | 0.03 | 2646 | 14.98 | < .001 |
| Awareness | Between | –1.16 | 0.14 | 154 | –8.51 | < .001 | 0.02 | 0.06 | 154 | 0.34 | .733 |
| | Within | –0.68 | 0.04 | 2646 | –17.23 | < .001 | –0.10 | 0.03 | 2646 | –3.78 | < .001 |
| Clarity | Between | 1.24 | 0.72 | 154 | 1.73 | .085 | 0.67 | 0.27 | 154 | 2.46 | .015 |
| | Within | 0.15 | 0.10 | 2646 | 1.45 | .147 | –0.01 | 0.06 | 2646 | –0.14 | .886 |

Note. These models also included a random slope of cubic time. The far-left column indicates each predictor variable with both person-centered (within) scores and overall (between) scores. Bold rows are indicative of statistically significant findings at $p < .05$. *b* values are interpreted like a regression analysis. For within scores, a 1-point increase compared to an individual’s centered average relates to *b* points increase in positive and negative affect. For between scores, a 1-point overall increase in each domain of emotion dysregulation relates to *b* points increase in positive and negative affect.

2.2. Intraclass correlation coefficients

For nonacceptance, the ICC was .62: 62% of the variability in nonacceptance scores was attributed to between-person differences, meaning that 38% of the variability was due to daily changes (i.e., within-person). ICCs for modulate, awareness, and clarity were .70, .69, and .58, comparable to studies examining ICCs for specific strategies (i.e., reappraisal, mindfulness, suppression; Brockman et al., 2017) and consistent with the hypothesis that individuals would vary in ER abilities across the study.

2.3. Positive affect model

Model statistics are presented in Table 1. Positive affect changed significantly across time. On days when individuals (i.e., within-person) reported higher negative affect, had more difficulty modulating emotional experiences, and lacked more emotional awareness than usual, they reported decreased positive affect (consistent with the hypothesis regarding associations between daily ER abilities and affect). Higher than typical emotional clarity and nonacceptance difficulties did not predict positive affect. When using each participant’s overall mean as a predictor (i.e., between-person), greater difficulty modulating emotions and a higher lack of awareness were related to lower levels of positive affect, consistent with hypotheses. Overall emotional clarity and nonacceptance difficulties did not predict positive affect, and overall negative affect did not predict positive affect. Predictors accounted for approximately 27% of the variance in positive affect scores using a pseudo R^2 effect size.

2.4. Negative affect model

Negative affect scores did not change significantly across time. On days when individuals reported lower positive affect, greater nonacceptance, lack of emotional awareness, and more difficulty modulating emotions than usual, they also reported higher negative affect (and lower negative affect for awareness; consistent with hypotheses except for the awareness finding). Higher than typical emotional clarity did not predict negative affect. When using each participant’s overall mean, greater difficulties with nonacceptance, modulating emotions, and emotional clarity were related to higher negative affect (also consistent with hypotheses). Overall positive affect and lack of emotional awareness did not predict negative affect. Predictor variables accounted for approximately 63% of the variance in daily negative affect scores.

3. Discussion

This study examined variability across and within individuals in perceived state ER abilities, as well as relationships between daily and overall ER abilities and affect using a daily-diary design. We aimed to inform models of ER that implicate flexible behavioral repertoires as central to well-being and psychopathology (Gratz & Roemer, 2004; Gross, 1998, 2001; Hayes et al., 2011). Although flexible use of ER strategies is associated with environmental adaptation and better mental health (Aldao et al., 2015) and associations between daily ER strategies and outcomes have been established (Blanke et al., 2020; Brockman et al., 2017), we extend these findings to perceived ER abilities.

Consistent with the contextual nature of ER abilities, participants varied in their perceived ability to manage emotional experiences, meaning that perceived ER abilities fluctuated daily. On days when individuals had more difficulty modulating emotional experiences and perceived a greater lack of awareness than usual, they reported lower positive affect. On days when individuals had higher nonacceptance, more difficulty modulating, and more trouble fostering awareness than usual, negative affect also increased for nonacceptance and modulate but decreased for awareness. Higher overall state ER components (i.e., modulate, awareness, acceptance, clarity) were also associated with affectivity.

Findings regarding individual variability were expected, given individual variability in behavioral processes using EMA designs (Finkelstein-Fox et al., 2020; Pavlacic, Schulenberg, & Buchanan, 2021). Positive and negative affect are not inherently good nor bad as this experience is dependent on context; however, the literature has theorized that higher positive affect and lower negative affect are components of well-being (Diener et al., 1999). Although positive and negative affect are commonly assessed as outcomes in ER literature (i.e., including EMA studies examining associations between ER strategies and affect; Brans et al., 2013), the psychological flexibility model emphasizes acceptance of emotional states in the service of valued living rather than modification of affective states (Sewart et al., 2019). However, given that 1) domains of acceptance (e.g., activity engagement, willingness) correlate with affective states (Beacham et al., 2015); 2) negative and positive affective states relate to decreased and increased success behavior consistently with values, respectively (Williams et al., 2015); and 3) positive affective states serve as a source of resilience in the presence of external and internal difficulties (Zautra et al., 2005), affect appears to be integral to daily ER abilities. Taken together, the results demonstrate the importance of perceived state ER abilities in predicting affective states and suggest the importance of focusing not only on dispositional ER abilities, but also perceived in-the-moment ER abilities for improving outcomes.

Clinically, these findings suggest that enhancing daily ER abilities has the potential to influence well-being, which may in turn contribute to greater engagement in valued living (Williams et al., 2015). Broadly, increases in emotion dysregulation could reflect elevated psychological inflexibility or unwillingness to experience aversive experiences, given the strong correlation and conceptual similarities between ER and psychological inflexibility (Kennedy et al., 2021; Lavender et al., 2017). Regarding specific ER domains, nonacceptance items on the S-DERS assess difficulties accepting emotional states, which parallels acceptance or openness to emotions within the context of the psychological flexibility model (Coyne et al., 2021). Similarly, the focus of awareness and clarity on acknowledgement and identification of emotional states could reflect present moment awareness (Fletcher & Hayes, 2005; Lavender et al., 2017), and difficulties modulating emotions overlap with attempts to eliminate emotional experiences (i.e., experiential avoidance) that potentially impact values-consistent behavior.

In line with connections between specific ER abilities and psychological flexibility, and the potential utility of integrating daily diary data collection with psychotherapy (McDevitt-Murphy et al., 2018), within-individual changes in nonacceptance could facilitate delivery of

acceptance-based strategies that focus on fostering emotional awareness (Coyne et al., 2021). Additionally, changes in awareness and clarity could lead to mindfulness interventions that foster present moment awareness (e.g., Kabat-Zinn, 2015). Adjustments in emotional modulation could warrant interventions designed to decrease experiential avoidance and thus promote valued living. Taken together, understanding individual deviations in daily ER could inform adaptations to evidence-based interventions, particularly process-based interventions that match treatment procedures to individual psychological problems in flexible fashion (Hayes & Hofmann, 2018).

Regarding awareness, these items involve acknowledging emotional experiences (Lavender et al., 2017). It is possible that participants less able to acknowledge emotions or unaware of negative emotions were less likely to endorse negative affect, given that the S-DERS assesses negative emotional states. Consistent with the above, these results inform process-based interventions (Hayes et al., 2011; Hayes & Hofmann, 2018; Persons, 2022) and experience sampling methodologies (Colombo et al., 2020), which emphasize individuality and understanding fluctuations in behavior change processes to guide clinical decisions (Kurtz et al., 2019; Persons, 2022).

3.1. Limitations & future research

While these results have utility, several study limitations warrant consideration. The student sample limits generalizability. Although the analyses afford an understanding of individual and overall differences in perceived ER abilities and daily relations with affect, they are correlational and not causal. However, the 21-day design and within-person MLM analyses provide a detailed evaluation of individual-level variability, which is critical for understanding individual fluctuations in ER abilities instead of only between-person differences (e.g., Wang & Maxwell, 2015). Further, examination of perceived ER abilities using ecological assessment has advantages, including controlling for factors impacting responding such as recall bias, and enhancing ecological validity given that assessment occurs in an individual's daily environment (Shiffman et al., 2008).

Future studies would benefit from examination of lagged relationships between perceived state ER and other behavior change processes (e.g., valued living) to better understand temporal relationships and associations between processes. Additionally, replication of the current study in clinical settings to inform individualized adaptations to evidence-based interventions is essential. Given the importance of context in ER (Aldao, 2013) and lack of assessment of contextual factors, future daily diary studies are encouraged to include daily assessments of aspects of context (e.g., interpersonal interactions, context-oriented goals) that predict changes in perceived ER. One potential example could be assessment of number of daily stressors (Finkelstein-Fox et al., 2020) in conjunction with ER abilities and other process-based outcomes to understand the impact of external stressors. Applied to a clinical context, ER abilities particularly impacted by aspect of contexts could facilitate provision of a more individualized intervention.

Regarding additional limitations and future research directions associated with assessed constructs, the present study measured a small number of perceived ER abilities and aspects of well-being that may not fully translate to certain theoretical models (e.g., psychological flexibility model). Future studies would benefit from expansion in terms of domains assessed, which could include assessment of ER strategies (e.g., reappraisal; Gross & John, 2003) in conjunction with perceived abilities and context. In addition, research incorporating assessment of daily relationships between ER abilities and psychological flexibility processes is needed to inform an understanding of associations between behavioral processes (Arch et al., 2022). Regarding the large effect size for negative affect models, it is possible that the larger effect size compared to positive affect models could be attributed to the strong relationship between negative affect and emotion dysregulation. In addition, as the S-DERS emphasizes regulation of negative emotional

states, future work should consider extending this work to examine ER associated with positive emotions (Weiss et al., 2015).

4. Conclusion

Domains of perceived state ER varied daily. In general, on days when individuals had more difficulty regulating their emotions than usual, positive affect decreased and negative affect increased. Future research should continue examining processes of behavior change, such as ER, in multilevel frameworks, which could inform research programs, individualized interventions, and multilevel assessments of behavioral processes (Persons, 2022). If the field of clinical psychology is to focus on understanding, assessing, and targeting psychological processes with evidence-based interventions, this approach needs to be individualized (Hamaker, 2012), ecologically valid, and adaptable contingent on individual variation.

Author note

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Data sharing

De-identified data are available upon reasonable request.

Declaration of competing interest

Dr. Laura J. Dixon serves on the editorial board at the *Journal of Contextual Behavioral Science*. The authors have no other declarations of interest to disclose.

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