Time to reappraise or distract? Temporal and situational context in emotion regulation in daily life

Hiekkaranta, A.P.; Kirtley, O.J.; Eisele, G.; Houben, M.; Lafitl, G.; Myin-Germeys, I.

DOI:
10.31234/osf.io/de9wy

Publication date:
2022

Document Version
Early version, also known as pre-print

Time to reappraise or distract? Temporal and situational context in emotion regulation in daily life

Anu P. Hiekkaranta[1]* , Olivia J. Kirtley[1,2,3] , Gudrun Eisele[1] , Marlies Houben[1,4] , Ginette Lafit1[5] , Inez-Myin-Germeys[1,2,3]

[1]*KU Leuven, Department of Neurosciences, Research Group Psychiatry, Center for Contextual Psychiatry, Leuven, Belgium*
[2] *The Leuven Child and Youth Institute, KU Leuven, Belgium*
[3] *The Leuven Brain Institute, KU Leuven, Belgium*
[4] *KU Leuven, Department of Neurosciences, Research Group Psychiatry, Mind Body Research, Leuven, Belgium*
[5] *KU Leuven, Department of Psychology, Research Group of Quantitative Psychology and Individual Differences, Leuven, Belgium*

* Corresponding author: Anu P. Hiekkaranta, KU Leuven, Department of Neurosciences, Research group Psychiatry, Center for Contextual Psychiatry, Research Group Psychiatry, O&N 5b, Herestraat 49, Box 1029, Leuven 3000, Belgium

E-mail: anupauliina.hiekkaranta@kuleuven.be

Ethical approval reference: G-2018 07 1285

Funding:
The research leading to these results has received funding from a Research Foundation Flanders Odysseus grant to IMG (FWO GOF8416N), supporting APH, OJK, and GL. OJK is currently also supported by a Senior Postdoctoral Fellowship from Research Foundation Flanders (FWO 1257821N). At the time of the data collection GE was supported by the Odysseus grant to IMG (FWO GOF8416N) as well.

Abstract

Contextual factors influence how people regulate their everyday emotions. While daily life is rich with situations that evoke emotion regulation, few studies have broadly investigated the role of context in regulating emotions in response to naturally occurring negative events. In this study, we use a structured diary technique - the Experience Sampling Method - to test how different types of contextual factors are associated with using reappraisal and distraction to regulate daily emotions in $N = 74$ young adults from the general population. The following contextual factors were assessed: time of the day, weekday, tiredness, event stressfulness, and event type. We found that higher stressfulness of negative events was associated with using more distraction within- and between-person and using more reappraisal between persons. Time of day and weekday were not associated with reappraisal or distraction use, suggesting that variation in people's external environments due to temporal patterns does not influence reappraisal or distraction use. However, tiredness was positively associated with distraction and reappraisal use within persons. Exploratory analyses suggested that experiencing time pressure affords less distraction use, and that experiencing physical discomfort affords less reappraisal use. These findings underscore the dynamic nature of emotion regulation, and the importance of context in everyday emotion regulation.

Keywords: emotion regulation, experience sampling method, reappraisal, distraction, environmental affordances

Time to reappraise or distract? Temporal and situational context in emotion regulation in daily life

Throughout the day we experience a variety of emotions from contentment and happiness to irritation and anger. The ability to regulate emotions is a fundamental process that allows people to meet the complex and varying challenges of everyday life in an adaptive manner, consequently influencing psychological adjustment and mental well-being (Lazarus, 1991; Aldao, 2013). Emotion regulation refers to the process of influencing the experience, type, and expression of emotions (Gross, 1998; 2015). Theoretical frameworks, such as Gross's (2015) process model of emotion regulation, conceptualize emotion regulation as the application of various strategies to regulate emotions, which involve different degrees of engagement with emotions or emotional situations.

In the current study, we focus on two frequently used strategies from the process model: distraction and reappraisal (Gross, 1998; 2015). Reappraisal refers to reinterpreting the meaning of an emotional situation, such that its emotional impact is changed. For example, it can entail viewing a job interview as an opportunity to learn as opposed to a stressful event. Distraction refers to efforts people make to move their attention away from an emotional situation. For example, distraction can involve going to the movies while experiencing nervousness before a job interview. A major feature that sets these particular strategies apart is that regulating emotions via reappraisal requires cognitive engagement with the situation while distracting oneself entails disengagement from the situation (Parkinson & Totterdell, 1999). Engagement with and processing of negative emotional situations by reappraising their meaning, is theorized to be essential for long-term emotional well-being, and helpful when the same or similar situations are encountered again (Wilson & Gilbert, 2008; Gross, 2015). In contrast, while distraction provides momentary relief from distress, researchers have suggested that distraction use does not offer the same long-term benefits, because particularly when negative situations

are unavoidable, they must be processed and addressed properly (Levine et al., 2012). Therefore, given that the use of reappraisal can help people view negative situations more positively and to make sense of them, it is important to understand when and why reappraisal is used, and when and why people opt for disengagement strategies, such as distraction.

The dynamic nature of emotion regulation

The process model of emotion regulation considers emotion regulation an inherently dynamic activity, with contextual factors influencing the selection and implementation of strategies as well as their effectiveness (Gross, 2015; Aldao, 2013). In the present study, we focus on investigating the antecedents of emotion regulation, that is, contextual factors that may influence how much and what type of emotion regulation is employed (Colombo et al., 2020; Koval & Kalokerinos, 2022). Unlike the majority of experience sampling studies and laboratory experiments on emotion regulation, in the present study, we investigate the role of multiple different types of dynamic contextual factors at the same time.

In order to adopt a multilevel contextual approach, we utilize the perspective of *affordances* (Gibson, 1979); possibilities for emotion regulation that the situational context offers to individuals, given their current state (Koole & Veenstra, 2015). For example, contextual factors such as the availability of cognitive resources can influence affordances for reappraisal and different types of negative events may afford different degrees of alternative perspectives to employ for reappraisals. Investigating different types of contextual factors contemporaneously is important, because current theories of emotion regulation conceptualize emotion regulation as a process that is influenced by various simultaneous contextual factors related to the state and characteristics of the individual, the emotion-evoking events, and the external environment (Gross, 2015; Aldao, 2013; Koole & Veenstra, 2015). In the present study, we therefore include contextual factors from three levels of context: the current state of the individual (tiredness), negative events they encounter (event intensity and type), and the

external environment (time of day and day of the week). However, to study multiple contextual factors at the same time in an ecologically valid way, and to capture the dynamic nature of emotion regulation, it is necessary to investigate naturally occurring emotion regulation.

Recently, researchers have begun to complement the study of contextual factors in emotion regulation in the lab with daily life studies utilizing the Experience Sampling Method (ESM; Csikszentmihalyi & Larson, 1987). In ESM, participants receive notifications throughout the day on a mobile device, as they live their regular lives, which alert them to complete momentary questionnaires about their mood, state, thoughts, behaviors, and other fluctuating psychological constructs. The advantage of ESM is its ability to capture the experiences and behaviors of individuals as they go about their day and engage with personally relevant contexts and events (Myin-Germeys et al., 2018). Furthermore, while controlled laboratory experiments are extremely valuable for investigating fundamental mechanisms of emotion regulation, ESM excels at capturing how these fundamental mechanisms unfold in the real-world as individuals adapt their regulation strategies to ever-changing contextual demands without instruction or pre-selected emotion regulation options.

The role of event intensity in distraction and reappraisal use

Relatively few studies have investigated the associations between distraction, reappraisal, and contextual factors in everyday life. However, the use of reappraisal and distraction strategies to regulate emotions has received a great deal of attention in laboratory studies investigating the role of contextual factors in emotion regulation choice (Sheppes et al., 2011; Sheppes et al., 2014). Several laboratory experiments have demonstrated that when participants are given the choice between distraction and reappraisal use in response to negative stimuli, the intensity of the stimuli is associated with the choice of emotion regulation strategy. When viewing highly negative images, for example, of severe injuries, people prefer to employ distraction. In contrast, when viewing negative images that are low in emotional intensity, such

as a person with a sad expression, reappraisal is used more often (Sheppes et al., 2011; Sheppes et al., 2014). As discussed by Sheppes and colleagues (2014), compared with distraction, engaging in reappraisal is a cognitively more complex process because alternative interpretations must be formulated which are both consistent with the original stimuli, but also in conflict with the initial emotional information. According to the emotion regulation choice framework, derived from the process model (Gross, 2015), distraction use demands fewer cognitive resources and is therefore easier than reappraisal to apply in response to highly intense negative stimuli (Sheppes 2020). This explanation is also supported by the finding that when reappraisal is facilitated by providing participants with reappraisal sentences, they are more likely to select reappraisal over distraction (Sheppes et al. 2014).

Recent investigations of these effects in daily life also suggest that low-intensity emotional situations indeed afford more reappraisal (Hiekkaranta et al., 2021; Lennarz et al., 2019; Wilms et al., 2020) The role of intensity in distraction as a means of emotion regulation in daily life is currently less clear, as some have reported a relationship between higher intensity and more distraction use (Lennarz et al., 2019) and others have found no relationship (Wilms et al., 2020). One possible contributing factor in the discrepancy between daily life research and controlled experiments is that everyday emotion regulation involves various contextual factors beyond event intensity. These factors, such as tiredness, temporal variables, and different types of events are not captured and may vary across studies due to methodological features. For instance, Lennarz and colleagues (2019) collected emotion regulation data only on weekends, while Wilms and colleagues (2020), asked participants to report on their emotion regulation between measurement moments, at the same specific times each day. These features may result in temporal bias in terms of tiredness and the types of events that occur on measurement days or close to measurement moments. Therefore, to address these limitations, sampling throughout the day and across weekends and weekdays is necessary, as well as the

assessment of the potential role of event types, tiredness, and temporal variables in emotion regulation.

Temporal variation in emotion regulation affordances

Our daily lives consist of some unavoidable routines; we must wake up, carry out our responsibilities at some point during the day, and eventually prepare for rest and sleep. Days of the week also impose a structure upon our lives, which can result in differences between action possibilities for weekdays and weekends. We might then expect that the stable temporal patterns that organize our lives influence possibilities for engaging in distraction and reappraisal. From the perspective of emotion regulation affordances, different times of the day and week may broaden affordances for engaging in an array of activities such as work, hobbies, events, digital media, and social situations to distract oneself from unwanted negative emotions. Conversely, such affordances may also be restricted by the responsibilities people must carry out throughout their days and week. Indeed, the possibility that features of the emotion regulation context influence affordances for emotion regulation behaviors has been raised (Suri et al., 2018). Further, rumination, another cognitive emotion regulation strategy that, like reappraisal, requires engagement with emotional stimuli, has been found to vary along temporal patterns, decreasing at midday and increasing in the morning and evening (Takano & Tanno, 2011). Daily and weekly temporal patterns have also been shown to be related to the experience of boredom in daily life (Chin et al., 2017), suggesting that stable temporal patterns in the availability of stimuli could influence distraction possibilities. Therefore, in the present study, we aim to gain further insight into whether and how temporal patterns reflecting daily and weekly routines influence the occurrence of distraction and reappraisal as a means for emotion regulation.

Fluctuations in tiredness

Our internal environments also change throughout the day and week, influencing affordances for emotion regulation emerging from the relationship between individuals' current state and situational emotion regulation demands. Tiredness and consequently, the ability to perform cognitive tasks, fluctuate along a circadian rhythm (Blatter & Cajochen, 2007). Engaging in reappraisal requires cognitive resources and processing of the emotional situation or stimuli (Gross, 2015; Sheppes, 2020). In line with the cognitive resources perspective of the emotion regulation choice framework (Sheppes et al., 2014), studies using neuroimaging indicate heightened activation in the prefrontal cortex when participants are asked to use reappraisal (Ochsner & Gross, 2014). While studies have not specifically focused on the relationship between tiredness and reappraisal or distraction use, fatigue has been associated with lower performance on generative cognitive tasks, independently of circadian rhythm (Van Dongen et al., 2003), indicating that tiredness could influence the ability to construct reappraisals. Therefore, tiredness could also have an effect on the natural occurrence of reappraisal and distraction outside of experimental settings, but this assumption remains untested. Investigating the relationship between tiredness and reappraisal and distraction use in a natural setting is important because daily life studies can provide an ecologically valid examination of how tiredness is related to the emotion regulation process in the real world.

Reappraisal affordances in interpersonal and personal events

Suri and colleagues (2018) presented the idea that certain emotion-evoking events may be richer in possibilities for reappraisal generation. They operationalized reappraisal affordances by asking participants how easy it was to construct alternative interpretations for emotional situations or stimuli. In a series of experiments, they found that reappraisal affordances were positively associated with employing reappraisal over distraction, a finding later replicated by Young & Suri (2019). In Suri and colleagues' (2018) experiments, participants rated negative events in the realm of interpersonal situations, such as experiencing

unfair treatment, as high in reappraisal affordances and reappraisal affordances predicted choosing reappraisal over distraction. Suri and colleagues (2018) proposed that the complexity of social situations may explain the findings. Because social situations by nature involve multiple persons and potential relationships between them, they may provide greater opportunities for constructing alternative interpretations, thereby facilitating reappraisal. Moreover, English and colleagues (2014) found that when people were in the company of non-close others compared to when non-close others were not present, they reported elevated reappraisal use. Being in a less familiar company involves more uncertainty about the meaning behind the actions of others, which could also increase affordances for reappraisal generation about ongoing social situations. However, it is important to test whether specific negative interpersonal events actually evoke more reappraisal use in daily life. Experiments based on imagined scenarios, although an excellent way to assess reappraisal affordances in a controlled setting, are unlikely to capture the complexity of reappraising nuanced interpersonal negative events in real life, limiting the generalizability of findings. Furthermore, compared to imagined scenarios, social scenarios in real life are more personally relevant, and emotion regulation responses to them are likely more consequential to participants. Therefore, while negative social events may afford more reappraisal than non-social events, it is not clear if people actually make use of this affordance in their daily lives or if other factors such as event intensity are more influential in naturally occurring reappraisal.

The current study

In the current study, we used pre-existing ESM data of young adults (Eisele et al., 2020) to examine the momentary use of distraction and reappraisal at different times of the day and the week, at different levels of tiredness, and in response to different types and intensities of stressful events. The current study, including hypotheses, analysis plan, and analysis code were postregistered on the Open Science Framework, (https://osf.io/9zrge), meaning that pre-

existing data were accessed after the registration (Benning et al., 2019). We expected time of the day and weekday to be associated with the occurrence of both distraction (Hypothesis 1a) and reappraisal (Hypothesis 1b). Given the novelty of these hypotheses, we did not have expectations about the direction of the effect of time of the day or weekday on emotion regulation. As cognitive effort has been suggested as an important element in reappraisal and distraction use, we expected that when people feel more tired, they engage in more distraction (Hypothesis 2). Along the same line, we also expected that when people feel less tired, they engage in more reappraisal (Hypothesis 3). Further, given that previous research has found reappraisal to be negatively associated with emotional intensity, we expected event stressfulness to be negatively associated with reappraisal (Hypothesis 4). We also aimed to bring further insight into the role of event intensity in distraction employment in daily life, and we, therefore, tested the hypothesis that event stressfulness is positively associated with the use of distraction (Hypothesis 5). Furthermore, given that laboratory findings indicate high reappraisal affordances for interpersonal situations, we expected negative interpersonal events to be positively associated with reappraisal use (Hypothesis 6). While we expected each independent variable to explain variance in distraction and reappraisal, all of the relevant independent variables were included in the same models assessing reappraisal and distraction occurrence, allowing for the assessment of the independence of their contribution. In addition, given that the use of reappraisal and distraction to regulate emotions has been associated with age (Scheibe et al., 2015) and gender (Nolen-Hoeksema, 2012), we included age and gender as covariates in all analyses.

Furthermore, in laboratory experiments, reappraisal and distraction have been assessed in response to a single negative image or other stimuli at a time in a series of trials (e.g. Sheppes et al., 2014). On the other hand, in previous ESM studies the number of negative events between assessments is typically not assessed, however, participants are instructed to think about a

specific negative event, such as the most negative event since the previous assessment, when reporting their distraction and reappraisal use (e.g., Lennarz et al., 2019). Given that multiple negative events are likely to evoke more distraction and reappraisal use, and that it may be challenging for participants to distinguish which event their emotion regulation efforts are associated with, in the present study we also included the number of negative events as a covariate. Finally, after confirmatory analyses, we also conducted an exploratory analysis of the association between distraction and reappraisal use and several specific inter- and intrapersonal and ambiguous negative events, such as experiencing time pressure. As associations between event types and distraction and reappraisal use have not been investigated beyond work on reappraisal affordances of negative social events (Suri et al., 2018), we did not have specific expectations about the direction of these relationships.

Methods

Participants

A total of 163 Flemish adults participated in the original study from which data for the current study is derived. Emotion regulation and all contextual factors were investigated in half of the original sample, who received a longer ESM questionnaire, and therefore only data from 78 participants were eligible to be used in the current study. People were eligible to participate if they were Dutch-speaking, currently studying at a university or another higher education institution, were between 18-30 years old, and had not previously participated in a study using a mobile phone app. Participants were recruited via Facebook advertisements, flyers, and advertisements placed at the university campus and in local bars.

Procedure

The data used in the current study was originally collected for a study about participant burden and other methodological issues in ESM research (Eisele et al., 2020). The study was approved by the Social and Societal Ethics Committee of KU Leuven. In a baseline session of 30-60 minutes, participants provided written consent and filled in a questionnaire about basic demographic information and contact details. Baseline questionnaires were followed by instructions for the 14-day ESM period and a briefing on how participants would be paid according to their participation. Participants received a research smartphone that was used to deliver the momentary questionnaires using the MobileQ application (MobileQ; Meers et al., 2019). Participants were then randomly allocated to six conditions: a short ESM questionnaire 3 times per day, a short ESM questionnaire 6 times per day, a short ESM questionnaire 9 times per day, a long ESM questionnaire 3 times per day, a long ESM questionnaire 6 times per day or a long ESM questionnaire 9 times per day. The short questionnaire included ± 30 items, dependent on conditional branching, and the long questionnaire included ± 60 items also dependent on branching. Details of the procedure and both questionnaires in English and the original Dutch can be found in the pre-registration of the original study (Eisele et al., 2020). In the current study, we only used data from the long ESM questionnaire conditions because items about negative events were not included in the short questionnaire. Participants were briefed on how many times per day they would receive notifications. Those in the condition with 3 notifications per day received a €40 gift voucher as compensation for participation, while participation in the conditions with 6 and 9 notifications was compensated with €60 and €80 gift vouchers, respectively. During the baseline and ESM instruction session and post-ESM session, participants also filled in other questionnaires about their well-being and psychosocial factors, which were not used in the current study (for a full list, see Eisele et al., 2020). After the 14-day ESM period, participants also attended a post-test session during which they completed questionnaires about burden, social norms and ideal affect, depression, anxiety, self-

esteem, emotion regulation, and momentary and retrospective affect. These questionnaires were also not used in the current study. Participants received their compensation at the post-test session. Compensation was planned so that if participants filled in less than one-third of all ESM questionnaires they would receive a reduced compensation of €25, €30, and €40 gift vouchers, for the 3, 6, and 9 – notifications conditions, respectively. Participants had been informed that they would not receive the full payment if they failed to complete enough questionnaires, but were not told an exact reduction to their compensation. No participant filled in less than one-third of the ESM questionnaires sent to them and all participants were therefore paid the full compensation for their condition. A randomly selected subsample was also interviewed for 10 minutes about their experience of the ESM period.

Measures

All variables used in the current study were measured with the ESM, as a part of the momentary questionnaire. The data for the current study come from a pre-existing ESM study where most of the variables were rated with a 1-7 scale, and therefore the emotion regulation items had been adapted to a 1-7 scale as well to ease responding.

Reappraisal

Reappraisal was measured with the item: *To what extent did I, since the last beep, try to look at the cause of my feelings from a different perspective?* (Brans et al., 2013) (1 = not at all, to 7 = very much).

Distraction

Distraction was measured with a similarly worded item: *To what extent did I, since the last beep, try to distract myself from my feelings?* (Pasyugina et al., 2015) (1 = not at all, to 7 = very much).

Event type

At each notification moment, participants were asked to report which negative events had occurred since the previous notification. Participants could select which events occurred from a list of negative events. These event options were derived from a daily life study of positive and negative events (Bennik, 2015). The list included four interpersonal events: *I had an unpleasant interaction with other* (unpleasant interaction), *I was excluded or ignored* (excluded or ignored), *I was bothered by someone else's problems* (other's problems), *and I received negative feedback* (negative feedback) and four intrapersonal events: *I experienced time pressure* (time pressure), *I experienced physical discomfort* (physical discomfort), *I experienced a setback* (setback), *and I had to perform a boring or unpleasant activity* (boring/unpleasant activity). Two additional ambiguous negative events were included in the list, which were not considered to be clearly interpersonal or intrapersonal: *I performed badly* (poor performance) and *I experienced another unpleasant situation* (another unpleasant situation). The option *None of the above* was also included on the list. For each measurement occasion, the number of negative events that occurred since the previous notification was calculated first. Then, all observations where participants had selected only one option from the list will be coded as interpersonal, intrapersonal, ambiguous, or as no event. Observations with ambiguous events and no events were excluded from confirmatory analyses. Ambiguous events were excluded because participants could have interpreted them as either interpersonal or intrapersonal and it was not possible to assess how the events had been interpreted. All events, including ambiguous events, were included in the exploratory analyses of associations between each event type and emotion regulation. When participants reported multiple negative events, the event type was coded the same way unless events from multiple categories (interpersonal, intrapersonal, and/or ambiguous) were reported on the same occasion. In a situation where participants reported negative events from multiple categories, the event variable was excluded

from the analysis. The number of negative events reported by participants at each measurement moment was included as a covariate. Therefore, if a participant reported that they had felt excluded or ignored (interpersonal) and received negative feedback (interpersonal), the event type variable was coded as interpersonal and the number of events as two. To account for the possibility that excluding ambiguous events severely reduces the power to detect effects, we conducted a sensitivity analysis. In this analysis, the ambiguous events were coded as both interpersonal and intrapersonal at the same time.

Event stressfulness

The intensity of event stressfulness was measured with the item: *How stressful were those situations taken together?* (1 = not at all, to 7 = very).

Tiredness

The sum of ESM items *Right now, I feel energetic* and *Right now, I feel fatigued* (1 = not at all, to 7 = very) was taken as a measure of tiredness. Similar measures of tiredness have been used in studies on sleep and daytime functioning (for example, Hawkley et al., 2010). Cronbach's alpha was computed as a measure of internal consistency for the tiredness variable and was 0.63 within participants and 0.53 between participants.

Time of the day

Because participants were divided into three different sampling conditions, this variable was coded as notification blocks ranging from 0 to 8, as in the original methodological study (Eisele et al., 2020). In the nine notifications condition, the notifications within each day were numbered from 0 to 8. In the three and six notifications conditions, notifications were assigned the number of the nine-beep condition interval that they fell in. For example, a notification in the three notification condition delivered at 12:03 was assigned the number 3 because it falls

into the time window where the third notification of the nine notifications condition would be delivered.

Weekday

Weekdays were initially coded as a seven-factor categorical variable. In the postregistration for these analyses, we outlined a plan in the case that the seven-level variable presents convergence issues with the models that cannot be solved by increasing the number of iterations to produce the model. Following the postregistered plan, due to convergence issues, we coded the weekday variable as a categorical variable with two levels: weekdays and weekend days.

Subjective carelessness

Subjectively reported carelessness in responding to the ESM was assessed with the item *I filled in the questions attentively*. The item was responded to with a 1-7 scale. We excluded the entire questionnaire for measurement occasions when participants responded to this item with a rating of 2 or lower. We also conducted sensitivity analyses to check if removing responses rated with a 1-2 on the carelessness scale influenced the results.

Objective carelessness

Objectively assessed carelessness was recorded by an additional item (*Think back about what you were doing just before the beep. Please select answer option <not at all>*). Namely, participants were asked to select a specific response (to select the response 1 “not at all” on the 7-point Likert scale). In order to prevent participants from expecting the item, this item was not discussed during the pre-ESM briefing session and was only presented once a day, on days 3, 6, 9, and 12. We excluded participants who failed this attention check by choosing a response other than “not at all” one or more times.

Statistical analyses

Mixed effects multilevel models with random slopes were constructed to address all research questions using R software (R Core Team, 2019), R studio version 3.6.0 (RStudio Team, 2015) and the lme4 (Bates et al., 2015), and lmerTest (Kuznetsova et al., 2017) packages. Momentary observations were nested in persons. Two separate multilevel models were constructed. In Model 1, distraction was the outcome variable, with the time of the day, day of the week, event stress intensity, number of negative events, and tiredness as independent variables. The same independent variables, with the addition of event type, were entered in Model 2, with reappraisal as the outcome. Age and gender were added as covariates in both models. Because the emotion regulation variables were measured between assessments (*since the last beep*) and the tiredness variable was measured as "in the moment" (*right now*), the tiredness variable was set as lagged to the previous measurement moment (t-1). Participants were randomly allocated to conditions with a different number of measurements per day (3, 6, and 9). To account for the violation of data not missing at random, we also included the measurement condition and the interaction between tiredness and measurement condition in the models. The measurement condition was a factorial variable with three levels: 3 measurements per day, 6 measurements per day, and 9 measurements per day. We employed the alpha < 0.05 criterion as the inference criterion.

Power analysis

At present, conducting a power analysis for intensive longitudinal data such as ESM data is challenging, because determining initial parameter estimates is difficult. This is explained by the complexity of data itself, which is characterized by a multilevel structure with repeated measures within a short time interval (Lafit et al., 2020). To overcome these difficulties, we estimated power for the current study by using parameter estimates from two

previously collected large ESM dataset, the Twins dataset and the ZAPP dataset, which included ESM items similar to those used in the current study (Collip et al., 2013; De Wild-Hartmann et al., 2013; Thewissen et al., 2008) from the Maastricht University MERGE dataset library (for a list of studies included in the MERGE, see Appendix 1 in Rintala et al., 2019). For details of the power analysis and variables used to estimate parameters, see Appendix A.

At the alpha level 0.05, the following estimates for power were observed for an expected sample size of 78: time of the day block 8, (21:00 – 22:30 = 0.62), day of the week (weekday 5 = 0.67), tiredness (.97), and event stress intensity (1.0). Therefore, the power to detect the hypothesized effects of temporal variables time of day and weekday was potentially low (Hypotheses 1a and 1b). The sensitivity analyses showed that when the event type variable (coded as 0 = personal event, 1 = social event) explained an increase of 5% of in the intercept of the outcome variable, power to detect the effect was 0.99. This power analysis was a part of the postregistration, and was therefore conducted before accessing the data and before the final sample size, after excluding participants for reasons detailed in the data preparation, was known. We therefore also conducted the same power analysis again using parameter estimates from the two previously collected ESM dataset detailed above, with the sample size after exclusions, N = 74. The results did not differ, except that the power observed for temporal variables for a sample size of 74 was lower: time of the day block 8, (21:00 – 22:30 = 0.42), weekday (weekday 5 = 0.56). Given the power, we therefore interpret the findings on the role of temporal variables with caution.

Transparency and Openness

This study, including the hypotheses and data analysis code, was postregistered (registered after data collection but prior to accessing the data) on the Open Science Framework: https://osf.io/9zrge, using the registration template for ESM research (Kirtley et al., 2021). The

data is currently not publicly available, as additional studies may be conducted using this dataset, by researchers within and outside the research group who collected the dataset. Access to the dataset for the current study was granted via a data-checkout system (Scott & Kline, 2019), detailed in Appendix B.

Data preparation

Of the original 163 participants, three participants were excluded because they were not enrolled as students in a university at the time of the study and two participants dropped out of the study during the ESM period. Two additional participants were excluded due to technical issues which led to beeps being delivered at incorrect times. Only half of the sample received the longer ESM questionnaire including all of the variables used in the current analyses. Consequently, 77 participants in the shorter ESM questionnaire condition were not included in the analyses. In addition, the exclusion of participants based on carelessness resulted in the exclusion of two participants based on objective carelessness. A further three participants did not report any negative events and were therefore also excluded. Therefore, 74 participants were included in the main confirmatory analyses with 24, 25, and 25 participants in the 3, 6, and 9 measurement moments conditions, respectively. Sensitivity analyses were conducted to explore the possible influence of including these careless responders and conclusions remained unchanged. After exclusions, 1426 observations were included in the analyses with distraction as the outcome and 946 observations in analyses with reappraisal as the outcome.

Within-person predictors event stressfulness and tiredness were centered on each person's mean and both person-level means and within-person-centered variables were included in the models as predictors. To achieve model convergence for both models, one with reappraisal as the outcome, and the second with distraction as the outcome, we followed the steps outlined in the plan constructed before access to data, detailed in the postregistration.

When initial models including a random intercept and random effects for independent time-varying variables did not converge, we first increased the number of iterations on the models. As the models did not yet achieve convergence, we removed the random effects of the number of events, time, weekday, and event type from the models in the aforementioned order, which resulted in both models converging

Results

Descriptive statistics

As shown in Table 1, distraction use was reported in 46.0% of the measurement occasions, as indicated by a score of 2 or higher on the distraction item, and reappraisal use was reported slightly more often, in 52.9% of the measurement occasions, as indicated by a score of 2 or higher on the reappraisal item. The average number of negative events that occurred between measurement occasions was 0.6, ranging from 0 to 6 events. Negative interpersonal (social) events occurred 4.6% of the time between measurement moments, and negative personal events occurred more often, 21.5% of the time between measurement moments. On weekend days, one or more negative events were reported on 501 measurement occasions, and on weekdays, on 1442 measurement occasions (Table 1). Negative events were most likely to occur between 3:00 PM – 4:30 PM and the least likely to occur between 7:30 PM – 9:00 PM (Table 2). The compliance rate for ESM beeps was 80% in the $N = 74$ sample who received the longer ESM questionnaire including event type.

Table 1

Descriptive statistics, N = 74.

	Variable	Mean (SD)	Median	Range	% of use /occurrence
Demographics	Age	21.9 (1.8)	21.8	18 – 28	
	Gender (% females)	86%	-	-	
Emotion regulation	Distraction	2.1 (1.5)	1.0	1.0 – 7.0	46.0 %
	Reappraisal	2.1 (1.3)	2.0	1.0 – 7.0	52.9 %
Contextual variables	Number of negative events (total)	0.6 (0.9)	0	0 – 6.0	37.7%[a]
	Number of negative events (weekdays)	0.6 (0.9)	0	0 – 6.0	41.0%
	Number of negative events (weekends)	0.5 (0.8)	0	0 – 5.0	34.3%
	Negative social events	0.1 (0.3)	0	0 – 3.0	4.6 %
	Negative personal events	0.4 (0.6)	0	0 – 3.0	21.5 %
	Ambiguous events	0.1 (0.3)	0	0 – 2.0	10.5 %
	Tiredness	7.5 (4.5)	7.0	2.0 – 14.0	
	Event stressfulness	3.5 (1.4)	3.0	1.0 – 7.0	

a. The % of measurement occasions where one or more negative events were reported.

Table 2

Occurrence of one or more negative events

Time block	Frequency	% of occurrence
9:00 AM - 10:30 AM	201	39.1%
10:30 AM - 12:00 PM	220	41.0%
12:00 PM - 1:30 PM	244	42.2%
1:30 PM - 3:00 PM	194	37.2%
3:00 PM - 4:30 PM	234	42.7%
4:30 PM - 6:00 PM	237	40.5%
6:00 PM - 7:30 PM	222	38.6%
7:30 PM - 9:00 PM	186	34.4%
9:00 PM - 10:30 PM	205	35.4%

Temporal variables and emotion regulation

Time of day was not significantly associated with distraction or reappraisal. Weekday was also not significantly associated with distraction or reappraisal, as shown in Table 3.

Tiredness and emotion regulation

Within persons, tiredness at t-1 was significantly positively associated with reappraisal use in condition 2, (6 beeps), but not in condition 1 (3 beeps) or condition 3 (9 beeps). Tiredness at t-1 within persons was also significantly positively associated with distraction use in conditions 2 (6 beeps) and 3 (9 beeps), but not in condition 1 (3 beeps) (Table 3). Interaction effects between tiredness and measurement condition (3, 6, 9 beeps per day), were included to account for tiredness being a lagged t-1 variable. The interaction effects between tiredness and condition on distraction use were not significant (Table 4). Likewise, the interaction effects between tiredness and condition on reappraisal use were not significant with the exception that the interaction between tiredness and condition 2 vs condition 3 was significant and negative, suggesting that the positive effect of tiredness at t-1 and reappraisal at t0 was greater in condition 2 (6 beeps) compared to condition 3 (9 beeps). Between persons, tiredness was not associated with reappraisal or distraction use in any measurement condition.

Event stressfulness and emotion regulation

As shown in Table 3, within persons, higher event stressfulness was significantly associated with distraction use, such that more stressful events were associated with using more distraction. Between persons, participants who on average reported more stressful events, also used distraction more ($\beta = 0.50$, SE = 0.12, $p < .001$). Event stressfulness was not significantly associated with reappraisal within persons (Table 3) but was significantly associated with reappraisal between persons, such that those who on average reported more stressful events also used reappraisal more ($\beta = 0.26$, SE = 0.10, $p = .014$).

Event type

Event type (i.e., whether the negative event or events were personal or social) was not significantly associated with reappraisal, indicating that in daily life, negative events involving other people did not afford more reappraisal.

Covariates and emotion regulation

We controlled for the effect of age, gender, number of negative events, and measurement condition. The effects of these covariates were not significant on either distraction or reappraisal (Table 4).

Sensitivity analysis

As outlined in the postregistration, we conducted a sensitivity analysis to explore the influence of subjectively and objectively careless responders on the results. The direction of effects or their significance was not affected when objectively careless responders were included in the analysis, when subjectively careless responders were included, or when both types of careless responders were included at the same time. As planned in the postregistration, we also explored via a sensitivity analysis if coding ambiguous negative events as either personal events or social events influenced the results. Neither the direction of effects nor their significance was affected by the alternative coding schemes for personal and social event types.

Table 3

Distraction and reappraisal use in daily life. Results of the effects of dynamic independent variables in the mixed multilevel analyses. Effect size β per independent variable and per emotion regulation outcome.

Outcome		Intercept	Time of day	Weekday[a]	Stress intensity	Number of events	Event type[b]	Tiredness Condition 1[c]	Tiredness Condition 2[c]	Tiredness Condition 3[c]
Distraction	*β (SE)*	1.71	0.02	0.08	0.20***	0.05	*NA*	0.03	0.07*	0.05*
		(1.47)	(0.02)	(0.09)	(0.04)	(0.06)		(0.05)	(0.03)	(0.03)
	p-value	.249	.268	.360	<.001	.433		.539	.021	.034
Reappraisal	*β (SE)*	1.01	-0.01	0.07	0.08	0.02	0.16	-0.03	0.06*	-0.02
		(1.22)	(0.02)	(0.09)	(0.04)	(0.12)	(0.12)	(0.05)	(0.03)	(0.03)
	p-value	0.412	0.504	0.443	0.080	.850	.153	.490	.036	.429

Note. $p < 0.05$ *, $p < 0.01$ **, $p < 0.001$ ***. Betas refer to unstandardized beta coefficients.
[a]Betas represent the effect of the day being a weekday (Monday – Friday).
[b]Betas represent the effect of social events.
[c]Condition 1 = 3 beeps per day, condition 2 = 6 beeps per day, condition 3 = 9 beeps per day.

Table 4

Distraction and reappraisal use in daily life. Results of the effects of baseline variables and interactions in the mixed multilevel analyses. Effect size β per independent variable and per emotion regulation outcome.

Outcome		Age	Gender [a]	Condition 1/[b] Condition 2[c]	Condition 1/ Condition 3	Condition 2/ Condition 3	Tiredness X[d] Condition 1/ Condition 2	Tiredness X Condition 1/ Condition 3	Tiredness X Condition 2 / Condition 3
Distraction	*β (SE)*	-0.05 (0.06)	-0.02 (0.28)	-0.03 (0.25)	0.06 (0.25)	0.04 (0.24)	0.04 (0.05)	0.03 (0.05)	0.02 (0.04)
	p-value	0.398	0.938	0.919	0.803	0.877	0.450	0.608	0.713
Reappraisal	*β (SE)*	0.01 (0.05)	0.10 (0.24)	0.03 (0.21)	0.05 (0.21)	0.02 (0.20)	0.10 (0.06)	0.001 (0.05)	-0.09 (0.04)*
	p-value	0.793	0.672	0.891	0.827	0.929	0.076	0.863	0.035

Note: Betas refer to unstandardized beta coefficients.
[a]Betas represent the effect of being male. Betas refer to unstandardized beta coefficients.
[b]The / sign refers to contrasts where conditions were compared.
[c]Condition 1 = 3 beeps per day, condition 2 = 6 beeps per day, condition 3 = 9 beeps per day.
[d]The X refers to an interaction term.

Exploratory analyses

To explore the possibility that specific negative events may be related to the use of distraction and reappraisal, we conducted additional exploratory analyses with the variable event type replaced with the occurrence of each of the assessed negative events as an independent variable, one at a time (Appendix C). Experiencing time pressure was significantly negatively associated with the use of distraction (β = -0.50, SE = 0.11, $p < 0.001$). In addition, we observed a negative association between experiencing physical discomfort and using reappraisal (β = -0.18, SE = 0.09, $p = 0.049$).

Furthermore, given that the finding of a lack of significant relationship between reappraisal use and event stressfulness within persons was contradictory to hypothesis 4 and previous literature, we considered the possibility the finding may be explained by the inclusion of instances where multiple negative events occurred, as that is a notable difference between the current study and previous work. In previous work, the use of reappraisal and distraction has typically been assessed in response to a single stimulus (Sheppes et al., 2014) or one specific event that occurred between measurement moments (Lennarz et al., 2019). In the current study, we also included observations where multiple negative events occurred between measurement moments. We, therefore, conducted the main statistical analyses on the outcome reappraisal again, excluding instances where multiple negative events occurred. This exclusion did not influence the direction or magnitude of the effects between event stressfulness and reappraisal use and the between-person level (β = 0.28, SE = 0.10, $p < 0.01$) or within-person person level (β = 0.10, SE = 0.05, $p = 0.024$), though contrary to confirmatory analyses, the positive within-person effect was significant.

In addition, given that higher stressfulness of negative events may evoke more emotion regulation in general, to investigate the unique effect of stress intensity of each emotion regulation strategy, we added distraction to the model with reappraisal as the outcome variable

and found that distraction use was significantly positively associated with reappraisal use within-person (β = 0.22, SE = 0.03, p < 0.001) and between persons (β = 0.43, SE = 0.10, p < 0.001). Reappraisal use was positively associated with distraction use within-person (β = 0.30, SE = 0.03, p < 0.001) and between persons (β = 0.72, SE = 0.13, p < 0.001). Finally, because prior studies have reported a negative relationship between reappraisal and event stress intensity in daily life (for example, Hiekkaranta et al., 2021), we also explored the possibility that the relationship is non-linear. We conducted an additional analysis with reappraisal as the outcome variable, where a quadratic term was added to the event stressfulness variable but this effect was not significant (β = 0.04, SE = 0.03, p = 0.196).

Discussion

In the current study, using ESM, we investigated how several different types of contextual variables afford distraction and reappraisal use in the daily lives of young adults. Temporal variables time of day and weekday (weekend days vs weekdays) were not significantly associated with distraction or reappraisal use, contrary to hypotheses 1a and 1b. However, being more tired at the previous measurement moment was significantly associated with more distraction use in two measurement conditions, conditions with 6 and 9 beeps per day, supporting hypothesis 2. Tiredness at the previous moment was also significantly associated with more reappraisal in the 6 beeps per day condition, contrary to hypothesis 3. Opposite to what we expected with hypothesis 4, higher stressfulness of negative events was not associated with reappraisal use within-person, but was positively associated with reappraisal use between persons. On the other hand, higher stressfulness of negative events was also significantly associated with more distraction use, within- and between-persons supporting hypothesis 5. Event type (interpersonal vs. intrapersonal) was not significantly associated with reappraisal

use, contrary to hypothesis 6, however, exploratory analyses suggested that specific types of intrapersonal events may be related to reappraisal and distraction in daily life.

Temporal variables in emotion regulation

The power to detect temporal effects in the present study was low, and we therefore advise caution in the interpretation of the results on temporal variables. The results suggest that unlike rumination, distraction and reappraisal are not associated with times of the day (Takano & Tanno, 2011), or differ between weekends and weekdays. The distribution of negative events also did not differ considerably throughout the day or across weekends and weekdays. The variation in people's external environments due to temporal patterns does not appear to change affordances for reappraisal or distraction use, suggesting that other contextual or individual factors play a more influential role. One contributing factor to the lack of association between distraction and temporal variables could be the constant availability of smartphone distraction, which could substantially reduce naturally occurring variation in distraction possibilities. Indeed, recent research on smartphone distraction has found that people use their smartphones as a distraction from negative or unpleasant thoughts and situations (Throuvala et al., 2021). It may also be that the results reflect differences in daily and weekly routines and the specific external environments that people encounter in these routines, such that, for instance, hobbies and social situations may be more available during the week for some, and for others, during weekends.

Distraction and reappraisal use in a state of tiredness

We observed a positive relationship between the internal state of tiredness and distraction use as a means of emotion regulation, suggesting that distraction is an affordable strategy even in a state of tiredness. Theories of distraction conceptualize distraction as a cognitively low 'cost' way to regulate negative emotions (Gross, 1998; 2015), and therefore comparatively easy to employ when cognitive resources are scarce, such as in a state of

tiredness. Contrary to the theoretical position that reappraisal is more cognitively taxing (Gross, 2015; Sheppes 2020) and is, therefore, less likely to occur in a state of tiredness, we found that when measured six times per day, tiredness at the previous moment was associated with more reappraisal use in the following hours. A potential explanation is that cognitive strategies such as rumination, shown to peak in the morning and evening (Takano & Tanno, 2011), cognitive distraction, and reappraisal are more likely to occur in a state of tiredness, because behavioral strategies are too physically taxing to employ when tired, and the repertoire of affordable emotion regulation strategies is limited to cognitive strategies. It is, however, possible that more extreme states of tiredness or exhaustion, not captured by everyday fluctuation in the general population are associated with less reappraisal use. To explore this possibility, studies with populations who experience greater fluctuations in tiredness, are necessary. These populations include, for instance, shift workers, whose cognitive performance has been shown to be influenced by fatigue (Wright et al., 2013; San Chang et al., 2011). However, further validation of the relationship between reappraisal use, distraction use, tiredness, and cognitive performance in daily life are necessary.

Sampling schemes and assessing the role of tiredness

We observed differences in the lagged relationships between tiredness and both distraction and reappraisal across sampling scheme conditions. The strongest relationships were observed in the six-beep condition, suggesting that sampling schemes with six measurement moments may have been the most suitable for capturing the effect of tiredness in emotion regulation processes. One possible explanation for this is that with six beeps per day, there is more time for emotion regulation to take place between more sparsely spaced measurement moments compared to nine beeps per day. Further, with six beeps per day, the measure of tiredness at the previous moment is closer in time to the emotion regulation measure at the next

measurement moment, making it easier to capture the association, compared to the three beeps per day condition.

Stress intensity in distraction and reappraisal use

In line with ESM research with adolescents and laboratory experiments in adults, we found higher stressfulness of negative events to be associated with more distraction use (Lennarz et al., 2019, Sheppes et al., 2011; Sheppes et al., 2014), both within- and between-person. However, the current results are in contrast with those of Wilms and colleagues' (2020) who found no relationship between daily life distraction and event intensity with adults, and De France & Hollenstein's (2021) who observed a negative relationship between intensity and distraction use. In the current study, temporal variables, which were not assessed in previous studies, were not related to distraction or reappraisal use, suggesting that various sampling schemes are appropriate for capturing the occurrence of these strategies, and therefore, differences in sampling schedules across studies do not explain the discrepancy. The differences in results may instead reflect differences in ESM items between studies, or differences in less obvious methodological elements, such as ESM instructions. Unclear or inconsistent instructions on how to respond to ESM items and use the response scales may be amplified in intensive longitudinal research because ESM items are administered repeatedly in a noisier context outside of controlled testing conditions. Therefore, replication studies with the same instructions and ESM items are needed to resolve the discrepancy. Furthermore, in the present study, we assessed distraction use in response to specific negative events, which were presented to participants as a list within each measurement moment. This sets the current study apart from previous ESM studies on distraction use. It may be that presenting a list of specific events helps participants recall moments of distraction use, which may occur and pass very quickly in the midst of busy and noisy everyday life.

We also found that between persons, those who reported experiencing more stressful events in general also used reappraisal more. This finding may reflect the experience of prolonged heightened daily life stress driving the development of a broader emotion regulation repertoire in an attempt to cope with stressful events, though further studies are needed to explore this possibility. Contrary to our expectations, prior ESM (Wilms et al., 2020; Hiekkaranta et al., 2021), and laboratory research on emotional intensity and emotion regulation strategy selection (for example, Sheppes et al., 2011), we did not find a relationship between reappraisal use and the stressfulness of events within-person. Furthermore, in exploratory analyses, we observed that for measurement occasions where only one negative event occurred, higher stressfulness was associated with more reappraisal use. This result also appears to contradict the emotion regulation choice framework (Sheppes et al, 2014) that outlines reappraisal as less likely to be used for high-intensity negative situations because reappraisal requires more cognitive resources.

Other ESM studies have also observed a lack of a relationship between reappraisal and the emotional intensity of negative events (Lennarz et al., 2019; De France & Hollenstein, 2021). Overall, it appears that lab experiments report consistent relationships between event intensity, and both distraction and reappraisal, while in ESM studies, the same relationships are not always found. It is possible that in choice experiments, the simultaneous use of distraction and reappraisal occurs, but is not captured, while daily life studies capture emotion regulation via multiple strategies that are employed in response to a single event over several hours or a full day. Indeed we found reappraisal use and distraction use to be positively associated in the current daily life study, suggesting that reappraisal and distraction are often used simultaneously or in sequence. To explore another explanation for the discrepancy with existing findings and theory, we considered the possibility that the relationship between event intensity and reappraisal is non-linear. Specifically, it may be that the relationship between reappraisal

and event stressfulness follows an inverted U-shape, wherein increasing intensity of negative events evokes more reappraisal, until events become very intense, evoking less reappraisal. While, in the current study we did not observe evidence of this type of non-linearity, further studies optimized to capture a larger range of experiences over a longer period of time could explore this possibility further.

Furthermore, it may be that relationships between event intensity and reappraisal observed in the lab are more difficult to capture in daily life studies because most negative events captured throughout the day consist of minor hassles with low personal importance. In contrast, participants in emotion regulation lab experiments are explicitly trained and instructed to select and implement a strategy to regulate their emotions (Sheppes et al., 2014). Therefore, in daily life, event importance can interact with event intensity such that important low-intensity events evoke more reappraisal. In line with this possibility, two daily diary studies found that when people were asked about how they regulated their emotions in response to the most negative event of the day, possibly more important than other daily hassles, the same relationship between reappraisal and intensity were observed as in laboratory experiments (Hiekkaranta et al., 2021; Troy et al., 2019). It is therefore important that future studies on contextual factors in naturally occurring emotion regulation employ a broad range of contextual factors as well as interactions between them.

Finally, it may be that the presentation of a list of specific negative events in the current study also influenced the accuracy of participants' recall of event intensity and reappraisal use. It may be that the types of complex and multifaceted negative low-intensity situations in real life, such as learning experiences and challenges with potential benefits, that could be rich in reappraisal affordances, were not well-represented in the list. Therefore, while providing a list of negative events may help recall events and report on them more accurately, to achieve this benefit, it may be necessary to provide a broader list and/or personalize it.

Types of negative events

While the current results do not support the theoretical notion that naturally occurring interpersonal events afford more reappraisal in daily life, given that the results are based on a small number of observations of interpersonal events, they should be interpreted with caution. With this limitation in mind, the results suggest that while, as Suri and colleagues' (2018) experiments show, reappraisals are easier to construct in negative interpersonal situations, in daily life people do not always employ this affordance. The reason may be that even though reappraisals are easier to construct for interpersonal situations, it is not adaptive to do so. As suggested by Ford and Troy's (2019) framework of drawbacks of reappraisals, reappraisal use, may have disadvantages. For instance, employing reappraisal to reduce negative emotions in situations that are controllable can undermine motivation to modify the situation. Therefore, employing reappraisals based on how easy they are to generate, could result in more cost than benefit, as other contextual factors such as affordances for situation modification also influence how beneficial it is to reappraise a negative situation.

Exploratory analyses on the role of specific negative events on reappraisal and distraction use yielded two findings, although we advise the interpretation of these findings with caution, as they were not included in the postregistered analysis plan and are therefore exploratory. In the current study, we observed that experiencing time pressure was negatively associated with the use of distraction to regulate emotions. This finding is in contrast to the theoretical position that the experience of time pressure leaves fewer cognitive resources available for emotion regulation, making distraction more affordable than reappraisal (Sirois, 2023). The current results also contradict findings that behavioral disengagement coping has been associated with procrastinating, which can cause time pressure (meta-analysis; Sirois & Kitner, 2015). It may be that in daily life, the time pressure people experience most often is not intense, and therefore does not restrict cognitive resources considerably. We did not assess how

much or what kind of time pressure people experienced, or if distraction was employed as a means of procrastination, and we are not aware of other daily life studies on this topic. Therefore, we cautiously interpret this finding as a reflection of adaptive emotion regulation behavior in everyday life; when people are under time pressure to perform a task, distracting oneself from the negative experience instead of completing the task, could be unwise and costly, and therefore occurs less often. However, more studies on daily life procrastination, distraction as emotion regulation, and experiencing time constraints are needed to understand the relationship between distraction and time pressure.

In exploratory analyses, we also observed a relationship between experiencing physical discomfort and using less reappraisal, which may point to an adaptive tendency to not ignore physical issues by re-framing them, as that could be dangerous to one's health. A theoretical notion in line with the current results has also been suggested by Suri and colleagues (2018) and Lazarus (1991); primarily sensory experiences such as physical discomfort are less complex and therefore less open to alternative interpretations required for reappraisal.

Strengths and limitations

An important strength of the current study is the use of open science practices, as much as possible, throughout the investigation. The hypotheses and analysis plan were postregistered on the Open Science Framework, that is, registered prior to access to the data (Benning et al., 2019), in line with the developing movement in psychology toward more open, robust, and replicable science. All ESM items used in this study are also publicly available online in the ESM Item Repository (Kirtley et al., 2023). Another key strength of the current study is the inclusion of several different types of dynamic contextual factors at the same time. Together the results demonstrate the importance of considering the intensity, such as stressfulness of negative stimuli or events, and suggest that stress intensity is a key factor in the elicitation of everyday emotion regulation.

Despite these strengths, there are also important limitations to the current study. First, because we used pre-existing data where half of the original sample received a shorter version of the ESM survey, the final sample in this study was small (74 participants) and consisted only of university students. It is therefore unclear if the sample is representative of the general population young of adults and if the results would generalize to other groups. For instance, research on emotion regulation choice has suggested that as people age, they begin to prefer distraction to regulate emotions, over reappraisal (Scheibe et al., 2015), and older adults may therefore display different patterns of reappraisal and distraction use in daily life.

Furthermore, in the current study, we used data where three different sampling schemes were employed, resulting in a violation of the principle of data missing at random. To account for this issue, we included the sampling scheme as an independent variable in all analyses. While the sampling schemes were distributed randomly, it is possible that the non-random missingness could bias the results. Nevertheless, as shown in the study where the present dataset was originally used (Eisele et al. 2020) the sampling scheme did not influence participant burden or attentiveness. However, as indicated by the differing relationships between lagged variables observed across the sampling scheme, the present study also demonstrates how the ability to capture relationships of interest in daily life research can depend on the study design.

Another important limitation is that we did not assess discrete negative emotions, while prior research suggests that discrete emotional states may be related to the use of specific strategies, such as reappraisal and distraction in daily life (De France & Hollenstein, 2021; Silk et al., 2003). The study is also likely limited in the assessment of external factors, such as the range of possible negative events. In order to better capture how specific events are related to emotion regulation in daily life, a more individualized approach may be necessary.

It is also important to recognize that participants may misinterpret distraction and reappraisal items by considering that redirecting their attention to alternative perspectives on a

situation may be reported as both a distraction and a reappraisal. Further, participants may have reported other strategies such as sharing or situation modification as distraction as well. To limit possibilities for misinterpretation when assessing distraction, in future studies it may be necessary to follow up on distraction items by asking participants to report the specific thoughts or actions they engaged in as a means of distraction.

Finally, the current study focused on two strategies studied widely in laboratory experiments. However, in daily life, a variety of emotion regulation strategies commonly occur (Lennarz et al., 2019) and to understand the role of contextual factors in daily emotion regulation more comprehensively, an investigation of contextual factors across a broader array of strategies is necessary.

Conclusion

To summarize, in the current study we found evidence for the role of stressfulness of negative events in affording both reappraisal and distraction use in everyday life. In line with laboratory experiments, greater distraction use was associated with more stressful negative events. Further, we found tiredness to be positively associated with distraction and reappraisal use in daily life. Finally, we also found preliminary evidence for the role of specific negative events in daily life reappraisal and distraction use. Together the results underscore the important role of event stressfulness in everyday emotion regulation and demonstrate possibilities for the investigation of a variety of contextual factors simultaneously in daily emotion regulation processes.

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Informed Consent

Written informed consent was obtained from all individual participants included in the study.

References

Aldao, A. (2013). The future of emotion regulation research: Capturing context. *Perspectives on Psychological Science*, *8*(2), 155-172. https://doi.org/10.1177/1745691612459518

Bates, D., Maechler, M., Bolker, B., Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1). https://doi.org/10.18637/jss.v067.i01

Bennik, E. (2015). Every dark cloud has a colored lining: The relation between positive and negative affect and reactivity to positive and negative events. [Groningen]: University of Groningen.

Benning, S. D., Bachrach, R. L., Smith, E. A., Freeman, A. J., & Wright, A. G. C. (2019). The registration continuum in clinical science: A guide toward transparent practices. *Journal of Abnormal Psychology*, *128*(6), 528–540. https://doi.org/10.1037/abn0000451

Blatter, K., & Cajochen, C. (2007). Circadian rhythms in cognitive performance: methodological constraints, protocols, theoretical underpinnings. *Physiology & Behavior*, *90*(2-3), 196-208. https://doi.org/10.1016/j.physbeh.2006.09.009

Brans, K., Koval, P., Verduyn, P., Lim, Y. L., & Kuppens, P. (2013). The regulation of negative and positive affect in daily life. *Emotion*, *13*(5), 926. https://doi.org/10.1037/a0032400

Chin, A., Markey, A., Bhargava, S., Kassam, K. S., & Loewenstein, G. (2017). Bored in the USA: Experience sampling and boredom in everyday life. *Emotion, 17*(2), 359. 0 http://dx.doi.org/10.1037/emo0000232

Collip, D., Wigman, J. T. W., Myin-Germeys, I., Jacobs, N., Derom, C., Thiery, E., … van Os, J. (2013). From Epidemiology to Daily Life: Linking Daily Life Stress Reactivity to Persistence of Psychotic Experiences in a Longitudinal General Population Study. *PLoS ONE*, *8*(4), e62688. http://dx.doi.org/10.1371/journal.pone.0062688

Colombo, D., Fernández-Álvarez, J., Suso-Ribera, C., Cipresso, P., Valev, H., Leufkens, T., ... & Botella, C. (2020). The need for change: Understanding emotion regulation antecedents and consequences using ecological momentary assessment. *Emotion*, *20*(1), 30. https://doi.org/10.1037/emo0000671

Csikszentmihalyi, M., & Larson, R. (1987). The experience sampling method: Toward a systematic phenomenology. *Journal of Nervous and Mental Disease*, 175, 526-536.

De France, K., & Hollenstein, T. (2021). Emotion Regulation Strategy Use and Success During Adolescence: Assessing the Role of Context. *Journal of Research on Adolescence*. https://doi.org/10.1111/jora.12672

De Wild-Hartmann, J. A., Wichers, M., Van Bemmel, A. L., Derom, C., Thiery, E., Jacobs, N., … Simons, C. J. P. (2013). Day-to-day associations between subjective sleep and affect in regard to future depression in a female population-based sample. *British Journal of Psychiatry*, *202*(6), 407–412. http://dx.doi.org/10.1192/bjp.bp.112.123794

Eisele, G., Vachon, H., Lafit, G., Kuppens, P., Houben, M., Myin-Germeys, I., & Viechtbauer, W. (2020). The Effects of Sampling Frequency and Questionnaire Length on Perceived Burden, Compliance, and Careless Responding in Experience Sampling Data in a Student Population. *Assessment*, 107319112095710. https://doi.org/10.1177/1073191120957102

English, T., Lee, I. A., John, O. P., & Gross, J. J. (2017). Emotion regulation strategy selection in daily life: The role of social context and goals. *Motivation and Emotion*, *41*, 230-242. https://doi.org/10.1007/s11031-016-9597-z

Ford, B. Q., & Troy, A. S. (2019). Reappraisal reconsidered: A closer look at the costs of an acclaimed emotion-regulation strategy. *Current Directions in Psychological Science*, *28*(2), 195-203. https://doi.org/10.1177/0963721419827526

Gibson, J. J. (1979). The ecological approach to visual perception. Boston, MA: Houghton Mifflin.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, *2*, 271–299. https://doi.org/10.1037/1089-2680.2.3.271

Gross, J. J. (2015). The extended process model of emotion regulation: Elaborations, applications, and future directions. *Psychological Inquiry*, 26(1), 130-137. https://doi.org/10.1080/1047840X.2015.989751

Hawkley, L. C., Preacher, K. J., & Cacioppo, J. T. (2010). Loneliness impairs daytime functioning but not sleep duration. *Health Psychology*, *29*(2), 124. https://doi.org/10.1037/a0018646

Hiekkaranta, A. P., Kirtley, O. J., Lafit, G., Decoster, J., Derom, C., de Hert, M., ... & Myin-Germeys, I. (2021). Emotion regulation in response to daily negative and positive events in youth: The role of event intensity and psychopathology. *Behaviour Research and Therapy*, *144*, 103916. https://doi.org/10.1016/j.brat.2021.103916

Kirtley, O. J., Lafit, G., Achterhof, R., Hiekkaranta, A. P., & Myin-Germeys, I. (2021). Making the Black Box Transparent: A Template and Tutorial for Registration of Studies Using Experience-Sampling Methods. *Advances in Methods and Practices in Psychological Science*, *4*(1). https://doi.org/10.1177/2515245920924686

Kirtley, O. J. (2022). Advancing credibility in longitudinal research by implementing open science practices: Opportunities, practical examples, and challenges. *Infant and Child Development*, *31*(1), Article e2302. https://doi.org/10.1002/icd.2302

Kirtley, O. J., Hiekkaranta, A. P., Kunkels, Y. K., Verhoeven, D., Van Nierop, M., & Myin-Germeys, I. (2023). The Experience Sampling Method (ESM) Item Repository. OSF. https://doi .org/10.17605/OSF.IO/KG376

Koval, P., & Kalokerinos, E. K. (in press). Daily diaries and ecological momentary assessment. In J. J. Gross & B. Q. Ford (Eds.), Handbook of Emotion Regulation (3rd ed). Guilford Publications.

Koole, S. L., & Veenstra, L. (2015). Does emotion regulation occur only inside people's heads? Toward a situated cognition analysis of emotion-regulatory dynamics. *Psychological Inquiry*, *26*(1), 61-68. https://doi.org/10.1080/1047840X.2015.964657

Kuznetsova, A, Brockhoff, P.B., Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software*, *82*(13), 1–26. http://dx.doi.org/10.18637/jss.v082.i13

Lafit, G., Adolf, J., Dejonckheere, E., Myin-Germeys, I., Viechtbauer, W., & Ceulemans, E. (2020, June 1). Selection of the Number of Participants in Intensive Longitudinal Studies: A User-friendly Shiny App and Tutorial to Perform Power Analysis in Multilevel Regression Models that Account for Temporal Dependencies. https://doi.org/10.31234/osf.io/dq6ky

Lazarus, R. S. (1991). Emotion and adaptation. Oxford University Press on Demand.

Lennarz, H. K., Hollenstein, T., Lichtwarck-Aschoff, A., Kuntsche, E., & Granic, I. (2019). Emotion regulation in action: Use, selection, and success of emotion regulation in adolescents' daily lives. *International Journal of Behavioral Development*, *43*(1), 1-11. https://doi.org/10.1177/0165025418755540

Levine, L. J., Schmidt, S., Kang, H. S., & Tinti, C. (2012). Remembering the silver lining: Reappraisal and positive bias in memory for emotion. *Cognition & emotion*, *26*(5), 871-884. https://doi.org/10.1080/02699931.2011.625403

Meers, K., Dejonckheere, E., Kalokerinos, E. K., Rummens, K., & Kuppens, P. (2020). MobileQ: A free user-friendly application for collecting experience sampling data. *Behavior Research Methods*, 1-6. https://doi.org/10.3758/s13428-019-01330-1

Myin-Germeys, I., Kasanova, Z., Vaessen, T., Vachon, H., Kirtley, O., Viechtbauer, W., & Reininghaus, U. (2018). Experience sampling methodology in mental health research: new insights and technical developments. *World Psychiatry*, *17*(2), 123-132. https://doi.org/10.1002/wps.20513

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: The role of gender. *Annual Review of Clinical Psychology*, *8*(1), 161-187. https://doi.org/10.1146/annurev-clinpsy-032511-143109

Parkinson, B., & Totterdell, P. (1999). Classifying affect-regulation strategies. *Cognition & Emotion*, *13*(3), 277-303. https://doi.org/10.1080/026999399379285

Pasyugina, I., Koval, P., De Leersnyder, J., Mesquita, B., & Kuppens, P. (2015). Distinguishing between level and impact of rumination as predictors of depressive symptoms: An experience sampling study. *Cognition and Emotion*, *29*(4), 736-746. https://doi.org/10.1080/02699931.2014.932755

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rintala, A., Wampers, M., Myin-Germeys, I., & Viechtbauer, W. (2019). Response compliance and predictors thereof in studies using the experience sampling method. *Psychological Assessment*, *31*(2), 226. https://doi.org/10.1037/pas0000662

San Chang, Y., Wu, Y. H., Hsu, C. Y., Tang, S. H., Yang, L. L., & Su, S. F. (2011). Impairment of perceptual and motor abilities at the end of a night shift is greater in nurses working fast rotating shifts. *Sleep Medicine*, *12*(9), 866-869. https://doi.org/10.1016/j.sleep.2011.03.018

Scheibe, S., Sheppes, G., & Staudinger, U. M. (2015). Distract or reappraise? Age-related differences in emotion-regulation choice. *Emotion*, *15*(6), 677. https://doi.org/10.1037/a0039246

Scott, K. M., & Kline, M. (2019). Enabling confirmatory secondary data analysis by logging data checkout. *Advances in Methods and Practices in Psychological Science*, *2*(1), 45-54. https://doi.org/10.1177/2515245918815849

Sheppes, G. (2020). Transcending the "good & bad" and "here & now" in emotion regulation: Costs and benefits of strategies across regulatory stages. In *Advances in Experimental Social Psychology* (Vol. 61, pp. 185-236). Academic Press. https://doi.org/10.1016/bs.aesp.2019.09.003

Sheppes, G., Scheibe, S., Suri, G., & Gross, J. J. (2011). Emotion-regulation choice. *Psychological Science*, *22*(11), 1391–1396. https://doi.org/10.1177/0956797611418350

Sheppes, G., Scheibe, S., Suri, G., Radu, P., Blechert, J., & Gross, J. J. (2014). Emotion regulation choice: a conceptual framework and supporting evidence. *Journal of Experimental Psychology: General*, *143*(1), 163. https://doi.org/10.1037/a0030831

Sheppes, G., & Gross, J. J. (2011). Is timing everything? Temporal considerations in emotion regulation. *Personality and Social Psychology Review*, *15*, 319 –331. https://doi.org/10.1177/1088868310395778

Sheppes, G., & Gross, J. J. (2012). Emotion regulation effectiveness: What works when. In H. A. Tennen and J. M. Suls (Eds.), Handbook of psychology (2nd ed., pp. 391– 406). Indianapolis, IN: Wiley-Blackwell Press.

Sheppes, G. (2020). Transcending the "good & bad" and "here & now" in emotion regulation: Costs and benefits of strategies across regulatory stages. *Advances in Experimental Social Psychology*, 61, 185. https://doi.org/10.1016/bs.aesp.2019.09.003

Silk, J. S., Steinberg, L., & Morris, A. S. (2003). Adolescents' emotion regulation in daily life: Links to depressive symptoms and problem behavior. *Child Development, 74*(6), 1869-1880. http://dx.doi.org/10.1046/j.1467-8624.2003.00643.x

Sirois, F.M. and Kitner, R. (2015) Less adaptive or more maladaptive? A meta-analytic investigation of procrastination and coping. *European Journal of Personality, 29*(4), 433-444. https://doi.org/10.1002/per.1985T

Sirois, F. M. (2023). Procrastination and stress: A conceptual review of why context matters. *International Journal of Environmental Research and Public Health, 20*(6), 5031. https://doi.org/10.3390/ijerph20065031

Suri, G., Sheppes, G., Young, G., Abraham, D., McRae, K., & Gross, J. J. (2018). Emotion regulation choice: The role of environmental affordances. *Cognition and Emotion, 32*(5), 963-971. https://doi.org/10.1080/02699931.2017.1371003

Takano, K., & Tanno, Y. (2011). Diurnal variation in rumination. *Emotion, 11*(5), 1046. https://doi.org/10.1037/a0022757

Thewissen, V., Bentall, R. P., Lecomte, T., van Os, J., & Myin-Germeys, I. (2008). Fluctuations in self-esteem and paranoia in the context of daily life. *Journal of Abnormal Psychology*, *117*(1), 143–153. http://dx.doi.org/10.1037/0021-843X.117.1.143

Throuvala, M. A., Pontes, H. M., Tsaousis, I., Griffiths, M. D., Rennoldson, M., & Kuss, D. J. (2021). Exploring the dimensions of smartphone distraction: development, validation, measurement invariance, and latent mean differences of the Smartphone Distraction Scale (SDS). *Frontiers in Psychiatry*, 12, 199. https://doi.org/10.3389/fpsyt.2021.642634

Young, G., & Suri, G. (2020). Emotion regulation choice: A broad examination of external factors. *Cognition and Emotion*, *34*(2), 242-261. https://doi.org/10.1080/02699931.2019.1611544

Wilms, R., Lanwehr, R., & Kastenmüller, A. (2020). Emotion Regulation in Everyday Life: The Role of Goals and Situational Factors. *Frontiers in Psychology*, *11*, 877. https://doi.org/10.3389/fpsyg.2020.00877

Wilson, T. D., & Gilbert, D. T. (2008). Explaining away: A model of affective adaptation. *Perspectives on Psychological Science*, *3*(5), 370-386. https://doi.org/10.1111/j.1745-6924.2008.00085.x

Wright Jr, K. P., Bogan, R. K., & Wyatt, J. K. (2013). Shift work and the assessment and management of shift work disorder (SWD). Sleep Medicine Reviews, 17(1), 41-54. https://doi.org/10.1016/j.smrv.2012.02.002

Appendix A

The Twins dataset (Collip et al., 2013; De Wild-Hartmann et al., 2013) from the MERGE dataset library (for a list of studies included in the MERGE, see Appendix 1 in Rintala et al., 2019) included most of the variables also involved in the analyses of the current study. We, therefore, conducted a power analysis using the Twins dataset with variables: negative event intensity, tiredness, time of the day, weekday, and the covariates age and gender. Negative event intensity was measured as event unpleasantness ranging from 0 to -3 and tiredness was measured with one ESM item: *I feel tired* (1 = not at all to 7 = very much). Time of the day was transformed into the same nine time blocks as in the current study and weekday was included as a 7-level factor. The specific outcomes of reappraisal and distraction were not available in any existing dataset we had access to, therefore, as a proxy we used another emotion regulation variable available within the Twins dataset, rumination (*I am ruminating*, 1 = not at all - 7 = very much). We considered rumination to be a satisfactory proxy for distraction and reappraisal because it provides an estimate of the expected occurrence of an emotion regulation process in daily life as well as its relationship with other daily life variables. Moreover, as hypothesized in the current investigation regarding reappraisal and distraction, rumination has been shown to vary along temporal patterns in daily life (Takano & Tanno, 2011).

The event type variable or a similar proxy, was not available in the Twins dataset. Therefore, we conducted a separate additional sensitivity analysis with estimates of the proportion of interpersonal events from another existing study within the MERGE library, the ZAPP study (Thewissen et al., 2008). In this study, participants were asked to think about the most important event since the last beep and to report whether the event was personal or social (0 = intrapersonal, 1 = interpersonal). Only events which were rated as negative were included. In this additional sensitivity analysis, to estimate power we varied the effect of the variable event type by allowing for an increase of 1%, 2%, 5%, 10%, 20%, 50%, and 100% in the fixed

intercept. This means that when participants report an event as being interpersonal, there would be an increase in the fixed intercept of 1%, 2%,…, or 100%. This way, we gained an estimate of how power is affected by expected change in the effect of event type. Because the event type variable parameter estimates were derived from a different dataset, we did not have information about its random effects and therefore, we only estimated the fixed effect in the sensitivity analysis. We also assumed that the event type was linearly independent with the rest of the predictors included in the model, therefore, we used the parameter estimates from the power analysis reported above.

The power analysis was conducted with a Monte Carlo simulation with 1000 replicates with the parameter estimates derived from the Twins dataset and the ZAPP dataset. The study duration was set to 14 days with 3, 6, and 9 measurement occasions per day per participant condition, with 50 participants in each condition, as in the dataset that was used for the current study (current study, $N = 74$). The model for power analysis included rumination as the outcome variable, with time of the day, day of the week, event intensity, and tiredness as independent variables with random slopes and age as a covariate. Gender was not included as a covariate because there were no males in the Twins dataset used for power analysis. For each simulated sample, the power was estimated as the number of Monte Carlo replicates in which the null hypothesis that the fixed intercepts are not statistically significant from zero, is rejected. At the alpha level 0.05, the following estimates for power were observed for a sample size of 150: time of the day (block 4, 15:00 – 16:30, = 0.88 and block 8, 21:00 – 22:30 = 0.89), day of the week (weekday 5 = 0.93), tiredness (1.0), and event intensity (1.0). Age was not significantly associated with the outcome variable and therefore power to detect its effect was not calculated. The reappraisal, event type, and event stressfulness variables were only included in the long-format ESM questionnaire condition, in which we expected to have 78 participants. At the alpha level 0.05, the following estimates for power were observed for a sample size of 78: time of the

day block 8, 21:00 – 22:30 = 0.62), day of the week (weekday 5 = 0.67), tiredness (.97), and event intensity (1.0). Therefore, the power to detect the hypothesized effects of temporal variables time of day and weekday was potentially low (Hypotheses 1a and 1b). The sensitivity analyses showed that when the event type variable (coded as 0 = personal event, 1 = social event) explained an increase of 5% of in the intercept of the outcome variable, the power to detect the effect was 0.99.

We recognize that the parameter estimates used in this power analysis are not derived from a dataset that is identical to the dataset of the current study and we therefore do not assume this power analysis to be precise, but rather an estimate of how these models fit real data where we expect the effects to be similar to those in the current study. We hope therefore to provide a valuable power estimation derived from real ESM data that closely resembles the dataset used for the current study.

Appendix B

To access the dataset, we submitted an abstract via the Data Curation for Open Science (DROPS; Kirtley et al., 2022) - data access system of the Center for Contextual Psychiatry, KU Leuven, which was reviewed by the data manager of the dataset of the original study. After the abstract was approved, we then submitted a request for the variables used for the proposed analyses for the current study. As a part of the variable request, we provided a link to an OSF registration. Variables were then released to the lead researcher, along with a time- and date-stamped receipt of data access. The ESM items used in the current study are also publicly available to other researchers at the ESM Item Repository, and online ongoing project where ESM items, details of their use, and development are documented (Kirtley et al., 2023; https://esmitemrepository.com/).

Appendix C

Table 1

Distraction and reappraisal use in daily life. Results of the effects of event types in the mixed multilevel analyses. Effect size β per independent variable and per emotion regulation outcome (N=74).

Outcome		Unpleasant interaction	Excluded or ignored	Other's problem	Time pressure	Poor performance	Negative feedback	Physical discomfort	Setback	Boring/ unpleasant activity
Distraction	*β*	-0.04	0.12	0.25	-0.50***	0.04	0.05	0.02	0.04	0.07
	(SE)	(0.14)	(0.22)	(0.17)	(0.11)	(0.15)	(0.17)	(0.10)	(0.13)	(0.09)
	p-value	0.792	0.597	0.130	<.001	0.777	0.758	0.842	0.737	0.486
Reappraisal	*β*	0.02	-0.05	0.13	-0.10	0.07	0.19	-0.18*	0.10	0.04
	(SE)	(0.12)	(0.20)	(0.15)	(0.10)	(0.13)	(0.15)	(0.09)	(0.11)	(0.08)
	p-value	0.851	0.787	0.390	0.281	0.652	0.222	0.049	0.376	0.617

Note. Betas represent the effect of the occurrence of the negative event, $p < 0.05$, $p < 0.01$ **, $p < 0.001$ ***. Betas refer to unstandardized beta coefficients.