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Emotion regulation and the temporal dynamics of emotions: Effects of cognitive reappraisal and expressive suppression on emotional inertia

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The tendency for emotions to be predictable over time, labelled *emotional inertia*, has been linked to low well-being and is thought to reflect impaired emotion regulation. However, almost no studies have examined how emotion regulation relates to emotional inertia. We examined the effects of cognitive reappraisal and expressive suppression on the inertia of behavioural, subjective and physiological measures of emotion. In Study 1 (N = 111), trait suppression was associated with higher inertia of negative behaviours. We replicated this finding experimentally in Study 2 (N = 186). Furthermore, in Study 2, instructed suppressors and reappraisers both showed higher inertia of positive behaviours, and reappraisers displayed higher inertia of heart rate. Neither suppression nor reappraisal were associated with the inertia of subjective feelings in either study. Thus, the effects of suppression and reappraisal on the temporal dynamics of emotions depend on the valence and emotional response component in question.

Keywords: Emotional inertia; Emotion dynamics; Emotion regulation; Cognitive reappraisal; Expressive suppression.

Emotional well-being is not just about experiencing more positive and less negative emotions. The ability to flexibly adapt one's emotions to fluctuating situational demands is also a major component of psychological health (Hollenstein, Lichtwarck-Aschoff, & Potworowski, 2013; Kashdan & Rottenberg, 2010). A lack of such flexibility may result in emotions that are overly predictable across time, a phenomenon labelled *emotional inertia* (Butler, 2011; Suls, Green, &

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Hillis, 1998). Emotional inertia has been hypothesised to result, at least partly, from ineffective emotion regulation (Kuppens, Allen, & Sheeber, 2010; Suls & Martin, 2005). Indirect support for this hypothesis comes from studies relating inertia to indicators of maladjustment such as neuroticism (Suls et al., 1998) and depression (Kuppens, Allen et al., 2010), which are known to involve impaired emotion regulation (Gross & Munoz, 1995). Yet, research directly linking emotion regulation to emotional inertia is lacking. To address this gap, the current studies investigated how two widely studied forms of emotion regulation, expressive suppression and cognitive reappraisal, are related to emotional inertia.

Emotion dynamics

The patterns and regularities with which emotions fluctuate over time (i.e., *emotion dynamics*) reflect the inner workings of the affective system: how people emotionally respond to events and regulate their emotions (Hoeksma, Oosterlaan, & Schipper, 2004; Kuppens, Oravecz, & Tuerlinckx, 2010). Thus, studying the micro-level dynamics of emotions can provide important insights into the building blocks underlying emotional well-being and psychopathology (Hollenstein et al., 2013; Kashdan & Rottenberg, 2010; Wichers, 2014). While the number of studies examining associations between emotion dynamics and well-being has grown rapidly in recent years, a consensus regarding which specific pattern(s) of emotion dynamics reflect optimal functioning has not yet emerged.

A number of studies have linked greater variability and/or instability of affect with reduced well-being (e.g., Gruber, Kogan, Quoidbach, & Mauss, 2013) as well as with various psychopathologies (e.g., Ebner-Priemer et al., 2007; Farmer & Kashdan, 2014; Thompson et al., 2012), suggesting that emotional stability is central to psychological health. However, these studies examined fluctuations in self-reported mood across hours or days and the same may not hold for emotional fluctuations at shorter timescales (e.g., seconds), or for other components of emotional responding (e.g., behaviour, physiology). An alternative view proposes that healthy emotional functioning involves flexibility rather than stability (Kashdan & Rottenberg, 2010), and this may particularly hold at shorter timescales (Hollenstein et al., 2013; Koval, Pe, Meers, & Kuppens, 2013). Research supporting this latter perspective has found that increased moment-to-moment predictability (i.e., inertia) of negative emotions is related to lower well-being (e.g., Koval, Kuppens, Allen, & Sheeber, 2012; Kuppens, Allen et al., 2010) and increased risk of Major Depressive Disorder (MDD; Kuppens et al., 2012; van de Leemput et al., 2014).

Our aim in the current study was to investigate the role of emotion regulation specifically in relation to the latter aspect of emotional flexibility, focusing in particular on the effects of reappraisal and suppression on the inertia of negative emotions assessed in real-time using self-report, behavioural and physiological measures.

Emotion regulation

Emotion regulation refers to any process that decreases, maintains or increases emotional intensity over time (Gross & Thompson, 2007), thereby modifying the "spontaneous flow" of emotions (Koole, 2009, p. 6). This definition implies that emotion regulation should directly influence dynamical properties of emotions, such as inertia (Cole, Martin, & Dennis, 2004; Gross & Thompson, 2007; Thompson, 1990), yet studies testing this assumption are rare (see Buss & Goldsmith, 1998; Hoeksma et al., 2004). Here, we examine whether emotional inertia is associated with two widely studied emotion regulation strategies: cognitive reappraisal, an antecedent-focused strategy involving the reinterpretation of an emotion-eliciting stimulus; and expressive suppression, a response-focused strategy involving the inhibition of emotionally expressive behaviour. Previous studies have linked inertia of negative emotions with trait rumination (Koval et al., 2012), suggesting that emotional inertia may reflect a form of emotion dysregulation. Yet, it remains unclear how deliberate emotion regulation strategies, such as reappraisal and suppression, are related to emotional inertia. As we review later,

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the effects of reappraisal and suppression on (mean) levels of emotion have been studied widely. Thus, an important next step is to examine how these emotion regulation strategies relate to dynamical characteristics of emotions, such as emotional inertia.

Effects of reappraisal and suppression on (mean) levels of emotion

The effects of habitual reappraisal and suppression on average levels of emotional experience and expression have been studied widely. Self-reported habitual use of suppression has been linked with higher average levels of negative emotional experience, lower average levels of positive emotional experience and expression and with greater symptoms of affective disorders (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Gross & John, 2003). In contrast, trait reappraisal has been shown to relate inversely with these same measures (Aldao et al., 2010; Gross & John, 2003).

Numerous studies have also examined the more immediate emotional consequences of reappraisal and suppression in the lab. A recent meta-analysis by Webb, Miles, and Sheeran (2012) found that whereas suppression and reappraisal are both effective in regulating the behavioural expression of emotion, only reappraisal has a reliable influence on the experiential component of emotion, whereas suppression is largely ineffective in modulating subjective feelings (see also Gross & John, 2003). Outside the lab, suppression has been found to relate to momentary increases in negative feelings and decreases in positive feelings in daily life (Brans, Koval, Verduyn, Lim, & Kuppens, 2013). In contrast, the effect of reappraisal on subjective feelings in daily life appears to be weaker, but it may be associated with slight increases in positive mood (Brans et al., 2013; Totterdell & Holman, 2003).

Thus, suppression and reappraisal clearly differ in their consequences for average levels of emotions. However, given that emotions are inherently dynamical processes (Davidson, 1998; Kuppens, Oravecz et al., 2010), it is also crucial to examine how emotion regulation strategies, such as reappraisal and suppression, influence the unfolding of emotions over time.

Effects of reappraisal and suppression on emotion dynamics

Only a handful of studies have investigated the effects of reappraisal and suppression on the temporal dynamics of emotions (e.g., Dan-Glauser and Gross, 2011; Erk et al., 2010; Goldin, McRae, Ramel, & Gross, 2008; Walter et al., 2009). Furthermore, these studies have mostly measured very brief emotional responses (i.e., lasting milliseconds or seconds) to highly standardised stimuli such as film-clips or images. In contrast, emotions occurring in daily life may last several minutes or longer (Verduyn, Delvaux, Van Coillie, Tuerlinckx, & Van Mechelen, 2009). While other studies have examined the emotional consequences of reappraisal and suppression over periods of several minutes (e.g., Egloff, Schmukle, Burns, & Schwerdtfeger, 2006; Gross, 1998; Schmeichel, Volokhov, & Demaree, 2008), these studies were limited to examining effects on mean levels or simple change scores (i.e., post-induction level minus baseline level) of emotions. Thus, little is known about the effects of emotion regulation on more fine grained moment-to-moment temporal dynamics of emotion over longer epochs (e.g., minutes) and in contexts resembling those encountered in daily life (Aldao, 2013). We address these limitations in the current studies by examining how reappraisal and suppression relate to moment-to-moment emotional predictability (i.e., inertia) during naturalistic emotional tasks lasting several minutes.

Predicted effects of reappraisal and suppression on emotional inertia

Given that the overall intensity and temporal dynamics of emotions may be influenced by different factors (Frijda, 2007), one cannot simply infer how reappraisal and suppression will be related to emotional inertia from their effects on (mean) levels of emotion. Moreover, little is known

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about the associations between mean levels and inertia of emotions. Our predictions regarding the effects of reappraisal and suppression on emotional inertia are therefore largely driven by theory.

Given that emotional inertia reflects a tendency for emotions to be resistant to change, regulation strategies that afford flexibility in emotional responding should be related to lower inertia, whereas strategies characterised by rigidity should be associated with higher inertia. Initial support for this hypothesis comes from two studies linking rumination—a regulation strategy characterised by cognitive rigidity (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008)—to higher inertia of negative feelings and expressive behaviours (Koval et al., 2012). Following this line of reasoning, we predict suppression to be related to higher inertia. Specifically, because suppression involves sustained inhibition of emotional expressions, it should result in a rigid pattern of emotional behaviour. Put otherwise, continually suppressing one's emotions implies a high degree of emotional predictability from moment-to-moment. Furthermore, the continual self-monitoring required to successfully suppress one's emotions is taxing on attentional and cognitive resources (e.g., Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Richards & Gross, 2000), which is likely to undermine a person's capacity for flexible and adaptive emotional responding (Zelazo & Cunningham, 2007). Using expressive suppression, either habitually or in a specific context, may thus be effective in terms of decreasing the mean level of emotional behaviour, yet doing so may undermine a person's capacity for emotional flexibility (Salters-Pednault, Steenkamp, & Litz, 2010), resulting in higher levels of emotional inertia.

In contrast, we expect reappraisal to be related to lower levels of emotional inertia. Relative to suppression, reappraisal intervenes earlier in the emotion-generative process (Gross & Thompson, 2007) and recruits regulatory brain networks more rapidly than suppression (Goldin et al., 2008). Because reappraisal is faster acting than suppression, and influences emotional responding before an emotion reaches its full force, reappraisal may achieve more rapid emotional recovery. In line with this, Verduyn, Van Mechelen, and Tuerlinckx (2011) have found that cognitive reappraisal is associated with shorter emotion duration. Faster recovery is central to flexible emotional responding and is expected to correspond with lower levels of emotional inertia (Suls & Martin, 2005). Moreover, reappraisal is not associated with the same cognitive impairments as suppression (Richards & Gross, 2000), leaving intact one's ability to respond flexibly to fluctuating situational demands. Thus, reappraisal should be associated with lower emotional inertia. Supporting this view, Kuppens, Oravecz et al. (2010) found that trait reappraisal was positively related to the tendency for affect to return more quickly to baseline following perturbation, which is considered to be inversely related to emotional inertia (Hamaker, 2012).

The current studies

Our main aim in the current study was to test the predicted effects of reappraisal and suppression on the inertia of subjective feelings and behavioural expressions of negative emotions, as these two dynamical measures have been consistently linked to maladjustment in previous research (Houben, Van Den Noortgate, & Kuppens, 2014). To this end, we analysed archival data from two studies, in which participants completed naturalistic lab tasks designed to induce negative emotions. Although both studies were designed and collected prior to the formulation of the current hypotheses, we generated hypotheses before analysing the data, except where clearly stated that analyses were exploratory (see later). Sample sizes were determined based on participant availability, time constraints and available budget.[1] Not all measures collected in the original studies are reported here, but are available upon request. We report all data exclusions and manipulations in each study. In both studies, subjective feelings and behavioural expression of negative emotions were assessed continuously and

[1] Study 1 data were collected by T.H. and D.L. Study 2 data were collected by E.B.

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were used to calculate indices of emotional inertia (i.e., autocorrelations). In addition, both studies included measures of heart rate (HR) and Study 2 included a measure of positive emotional behaviours, allowing us to conduct exploratory analyses on the effects of reappraisal and suppression on the inertia of HR and positive emotions.

In Study 1, we examined how self-reported trait suppression and reappraisal are related to emotional inertia during an impromptu speech. In Study 2, we tested the effects of instructed suppression and reappraisal on emotional inertia during a conversation about a distressing film (see Butler, Wilhelm, & Gross, 2006). We predicted that suppression would be associated with higher inertia of both the experiential and behavioural components of negative emotions. In contrast, we predicted that reappraisal would be related to lower inertia of both negative feelings and behaviours. Finally, the current studies also allowed us to examine to what extent experiential, behavioural, and physiological inertia are correlated. This has not been examined before as previous studies on inertia have assessed only one component of emotional responding.

STUDY 1

In Study 1, we examined whether adolescents' habitual use of suppression and reappraisal in daily life were related to their levels of emotional inertia during a 3-minute video-recorded impromptu public speaking task. It may be especially important to study the processes giving rise to higher emotional inertia in adolescence as this is a critical period for the development of affective disorders such as depression (Rhode, Lewinsohn, Klein, Seeley, & Gau, 2013). Indeed, a recent study found that adolescents who displayed higher inertia were significantly more likely to be diagnosed with MDD almost three years later (Kuppens et al., 2012). Adolescence is a period of significant biological, psychological and social change, during which young people must learn to cope with intensified emotions (Allen & Sheeber, 2008; Hollenstein & Lougheed, 2013). Habitual use of ineffective emotion regulation strategies (e.g., suppression) during this transition may give rise to heightened emotional inertia (Kuppens et al., 2012).

Method

Participants

One hundred and fourteen adolescents (53 boys, 61 girls) aged between 12 and 16 years (M = 13.32, SD = 0.99) were recruited to take part in a larger study on affective functioning, comprising a number of tasks and physiological measures. Participants received a $20 gift voucher to a bookstore for their involvement in the study.

Materials and procedure

Participants attended the lab individually accompanied by a parent. Upon arrival, the experimenter provided a detailed description of the study including potential risks and benefits to both the parent and adolescent. Participants were individually seated in a room with obscured video cameras. First, participants completed a number of questionnaires including Gross and John's (2003) emotion regulation questionnaire (ERQ).

Emotion regulation questionnaire. The ERQ is a 10-item measure of habitual reappraisal and suppression in daily life, comprising a 4-item suppression subscale (e.g., "I control my emotions by not expressing them") and a 6-item reappraisal subscale (e.g., "I control my emotions by changing the way I think about the situation I'm in"). Mean scores in the current sample were 4.63 (SD = 0.98) for reappraisal and 3.78 (SD = 1.03) for suppression. Cronbach's alphas were .81 for the reappraisal subscale and .59 for the suppression subscale (the latter increased to .65 after excluding the item "when I am feeling positive emotions, I am careful not to express them").[2]

[2] For comparability with other studies using the ERQ, we report analyses based on the original 4-item suppression scale. However, all findings replicated when repeating analyses using the more reliable 3-item suppression subscale.

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Heart rate. Physiological sensors (electrocardiogram [ECG], skin conductance and respiration) were applied by a female experimenter. The ECG sensors consisted of two disposable sticker electrodes in Lead II configuration; one was placed 2 cm below the right collarbone and the second between the left hipbone and the last rib bone. All sensors were connected to an MP150 amplifier (Biopac Systems Inc., USA) via a battery pack (TEL100M-C) attached to the back of the participant's chair and were measured continuously at 200 Hz. Incoming physiological data were monitored, recorded and cleaned using AcqKnowledge 4.1 (Biopac Systems Inc., USA). HR was calculated as number of beats per minute from the raw ECG signal. The HR time series was derived as the mean HR for each 1-second bin of the 180 second speech.

Speech task. Following three restful baseline tasks (watching a calm film, paced breathing and quiet rest), participants then completed an impromptu speech task, which was video recorded and later coded for emotionally expressive behaviour (see later). For the speech task, participants were instructed to give a speech as if to their class at school on a topic of their choice. Next, participants completed a post-speech questionnaire including several items assessing self-conscious affect,[3] and then sat quietly for 3 minutes (recovery period).

Subjective experience of emotion. After the recovery period, participants rated their subjective feelings during the speech task using video-mediated recall (Gottman & Levenson, 1985): while watching the video-recording of their speech task on a monitor, participants continuously rated their subjective feelings at each moment during the task using a bipolar affect rating lever with the extremes labelled "calm" and "distressed" (the lever rested at the "calm" end via a spring). The position of the lever was continuously recorded in a psychophysiological channel, and later converted to 1-second bins and rescaled into scores from 0 (*calm*) to 100 (*distressed*). Video-mediated recall has been extensively validated as an accurate and reliable measure of subjective emotional experience (for a review, see Ruef & Levenson, 2007).

Coding of behavioural expression of emotion

Trained observers, blind to study hypotheses, coded each participant's videotaped speech for verbal and non-verbal cues of self-conscious affect (e.g., body tension, hiding, wavering voice) in real-time using the Self-Conscious Affect Code II (SCAC-II; Lanteigne, Glozman, & Hollenstein, 2010). The SCAC-II is a 7-item binary code indicating presence/absence of self-conscious behaviours: averted eye gaze, body tension, facial tension, vocal uncertainty, silence (5 or more seconds), hiding behaviours and nervous positive affect (e.g., nervous laughter). We summed the seven behavioural codes for every instant of the speech, such that self-conscious behavioural expression ranged from 0 to 7 (e.g., a 3 indicates the simultaneous expression of three self-conscious behaviours). We calculated the mean level for each 1-second interval, weighted by the proportional duration of each behaviour (e.g., if a participant was expressing two behaviours at the start of a given 1-second interval, and then expressed a third behaviour 0.5 seconds into the interval, then the value for that 1-second interval would be 2(0.5) + 3(0.5) = 2.5). A team of student coders were trained to a criterion of 80% agreement for code duration (duration-sequence based reliability analysis), 70% agreement for the onset of a code within 3 seconds and a kappa score of .65 (frequency-sequence based reliability analysis). Throughout the coding process, 20% of the videos were checked to ensure that this standard was maintained. Average reliability estimates were 88% for duration-based reliability, 78% for frequency-based reliability and kappa = .76.

[3] Self-conscious affect was assessed with seven items (e.g., "humiliated", "embarrassed", "worthless"), rated on a scale from 1 (*did not feel at all*) to 10 (*felt very strongly*), which formed a reliable scale (a = .86). Participants reported an average self-conscious affect score of 2.53 (SD = 1.53), which differed significantly from 0, $t(113) = 17.73$, $p < .001$.

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Data analyses

For all analyses, coded behavioural expressions of emotion (behaviour), self-reported experience of emotion (feelings) and HR, all assessed in real-time, were converted to 1-second bins. As the speech task lasted 3 minutes, there were 180 observations (i.e., seconds) per participant for each measure. Three participants had missing data for the ERQ and could therefore not be included in analyses, leaving a final sample of 111 adolescents. Due to technical problems, nine participants had some missing HR data (204 observations = 1% missing in total) and eight participants had some missing data for the behavioural coding (43 observations = 0.21% missing in total). To account for the hierarchical structure of this data, in which observations (Level-1) were nested within participants (Level-2), we used multilevel modelling (Snijders & Bosker, 2012). First, we conducted preliminary analyses to estimate descriptive statistics for mean levels and inertia of each emotion measure, and we calculated correlations between these measures, across the entire sample (see Appendix, Models 1 and 2). For our main analyses, we ran models estimating the associations between trait reappraisal and suppression, on the one hand, and mean levels and inertia of emotions, on the other hand (see Appendix, Models 3 and 4). All analyses were conducted separately with behaviour, feelings and HR as outcomes.

Results

Preliminary analyses

Descriptive statistics for mean levels and inertia of all emotion measures are shown in Table 1. The mean level of behaviour (estimated at 1.44) indicates that an average participant expressed 1.44 co-occurring self-conscious behaviours per second of the speech task (the maximum possible number of co-occurring behaviours per second was 7). The mean level of feelings was relatively close to the mid-point (M = 45.95) of the 0 (*calm*) to 100 (*distressed*) feelings scale. The mean HR during the speech was estimated at 87.24 beats per minute. Inertia levels (i.e., autoregressive slopes) for all three measures were positive, indicating that, on average, participants' levels of behaviour, feelings or HR at time t were positively associated with their levels of behaviour, feelings or HR at time t–5. Table 1 also displays correlations between mean levels and inertia of all emotion measures. Regarding correlations between mean levels and emotional inertia within measures, only the mean level and inertia of HR were significantly positively correlated. Regarding correlations between inertia

Table 1. *Descriptive statistics and correlations among mean levels and inertia of experiential, behavioural, and physiological measures of emotion in Study 1*

			Correlations				
Measure	*Estimate (SE)*	*95% CI*	*1*	*2*	*3*	*4*	*5*
Mean level (β_{00})							
1. Behaviour	1.44 (0.07)	[1.30, 1.59]	1.00				
2. Feelings	45.95 (2.19)	[41.61, 50.29]	.35***	1.00			
3. HR	87.24 (1.16)	[84.95, 89.54]	.07	.09	1.00		
Inertia (β_{10})							
4. Behaviour	0.37 (0.02)	[0.33, 0.41]	.10	.05	−.01	1.00	
5. Feelings	0.68 (0.02)	[0.64, 0.73]	.28**	.05	−.11	.36***	1.00
6. HR	0.18 (0.03)	[0.13, 0.23]	.28**	.23*	.26**	.03	.10

Note: Behaviour = coded behavioural expression of emotion on a scale from 0 to 7. Feelings = self-reported experience of emotion on a scale from 0 (*calm*) to 100 (*distressed*). HR = heart rate (in beats per minute). SE = standard error; CI = confidence interval.
Mean level and inertia estimates are from multilevel models (see Appendix, Models 1 and 2, respectively).
*p < .05; **p < .01; ***p < .001.

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Table 2. *Associations between trait reappraisal and suppression with mean levels and inertia of emotion in Study 1*

		Association with mean level			*Association with inertia*			
Outcome	*Parameter*	*Estimate (SE)*	*95% CI*	*p-Value*	*Parameter*	*Estimate (SE)*	*95% CI*	*p-Value*
Behaviour	Trait reappraisal (β_{01})	0.01 (0.07)	[−0.12, 0.15]	.834	Trait reappraisal (β_{11})	−0.02 (0.01)	[−0.04, 0.01]	.249
	Trait suppression (β_{02})	−0.02 (0.08)	[−0.17, 0.14]	.836	Trait suppression (β_{12})	0.05 (0.02)	[0.01, 0.09]	.024
Feelings	Trait reappraisal (β_{01})	1.01 (2.08)	[−3.10, 5.13]	.627	Trait reappraisal (β_{11})	0.00 (0.02)	[−0.03, 0.04]	.871
	Trait suppression (β_{02})	−1.93 (2.22)	[−6.34, 2.48]	.387	Trait suppression (β_{12})	0.03 (0.02)	[−0.01, 0.07]	.182
Heart rate	Trait reappraisal (β_{01})	1.00 (1.04)	[−1.07, 3.06]	.340	Trait reappraisal (β_{11})	0.03 (0.03)	[−0.02, 0.09]	.218
	Trait suppression (β_{02})	−2.02 (1.15)	[−4.29, 0.25]	.081	Trait suppression (β_{12})	0.00 (0.03)	[−0.05, 0.05]	.953

Note: CI = confidence interval.
Estimated associations with mean level (β_{01} and β_{02}) are from Model 3 (see Appendix). Estimated associations with inertia (β_{11} and β_{12}) are from Model 4 (see Appendix).
Approximate *d.f.* = 108.

levels across measures, the inertia of behaviour and feelings were significantly positively correlated.

Trait reappraisal and suppression in relation to mean levels of emotion

Estimated associations between standardised trait reappraisal and suppression scores with mean levels of each emotion measure are shown in Table 2. Neither reappraisal nor suppression were significantly associated with mean levels of behaviour, feelings or HR during the speech.

Trait reappraisal and suppression in relation to emotional inertia

Estimated associations between standardised trait reappraisal and suppression scores with inertia of each emotion measure are shown in Table 2. Trait suppression was significantly related to higher inertia of behaviour, as predicted. Specifically, participants scoring one standard deviation above the sample average on trait suppression were predicted to have an autocorrelation of .42 for negative behaviours, whereas participants with trait suppression scores one standard deviation below the sample mean were predicted to have an autocorrelation of .32. Trait reappraisal was not significantly related to the inertia of behaviour. Finally, we found no significant associations between either trait reappraisal or trait suppression and the inertia of feelings or HR.

Discussion

Study 1 aimed to provide a first test of the association between emotion regulation and emotional inertia. As predicted, trait suppression was related to higher inertia of the behavioural expression of emotion during the impromptu speech. Regarding trait reappraisal, although its association with behavioural inertia was in the predicted negative direction, this effect was not statistically significant. Contrary to our hypotheses, neither trait reappraisal nor suppression were related to the inertia of subjective feelings. Similarly, neither regulation strategy was related to the HR inertia during the speech task. Thus, the association

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between habitual suppression and emotional inertia appears to apply only to the expressive but not the experiential or physiological components of emotional responding.

It is interesting to note that trait suppression was not related to mean levels of self-conscious behaviour during the speech. Thus, although habitual suppressors did not (successfully) modulate the amount of self-conscious behaviour they expressed, they nevertheless displayed emotional inflexibility in the form of increased inertia of behaviours during the speech task.

We note that our failure to find an association between either trait reappraisal or suppression with mean levels of emotional behaviour expressed during the speech task is at odds with previous research (e.g., Butler et al., 2003; Gross, 1998, 2002; Egloff et al., 2006). However, previous studies have either examined how habitual reappraisal and suppression relate to trait affect (e.g., Gross & John, 2003), or how state reappraisal and suppression influence state levels of emotion (e.g., Egloff et al., 2006; Gross, 1998). In contrast, the current study related trait reappraisal and suppression to state levels of emotions during a specific task completed in the lab. Although individual differences in trait reappraisal and suppression may be relatively stable (Gross & John, 2003), whether an individual uses a specific regulation strategy in a given situation depends on myriad contextual factors (Aldao, 2013). Thus, we cannot rule out the possibility that adolescents who tend to habitually use a certain regulation strategy did not use that strategy during the impromptu speech.

There are also a number of possible explanations for the association between trait suppression and inertia observed in Study 1: suppression may cause higher inertia because it involves a rigid and continual inhibition of emotions, which impedes a person's ability to flexibly adapt their emotional responses to changing situational demands. Alternatively, individuals who display higher inertia (for reasons unrelated to suppression) may tend to use suppression because they lack the emotional flexibility required for employing other strategies (e.g., reappraisal). A third possibility is that trait suppression's association with inertia is due to its shared variance with other variables such as rumination (Nolen-Hoeksema et al., 2008) or depressive symptoms (Gross & John, 2003), which are themselves related to inertia (Koval et al., 2012). The correlational design of Study 1 does not allow us to tease apart these possible explanations. To address this limitation, we examined the effects of experimentally instructed reappraisal and suppression on emotional inertia in Study 2.

STUDY 2

In Study 2, we analysed data from an experiment on the effects of instructed reappraisal and suppression on emotional responding during a dyadic interaction (Butler et al., 2006). This provided an ideal opportunity to address the important question of the causal relations between emotion regulation and inertia, and to replicate our findings from Study 1. In this study participants' behavioural expressions of negative and positive emotions were coded, allowing us to also explore the effects of instructed reappraisal and suppression on positive emotional inertia.

Method

Participants

Using advertisements placed around Stanford University and on an email listserv for paid psychology research, 190 female undergraduates aged between 17 and 28 years (M = 20.05; SD = 1.89) were recruited (43.2% European American, 34.7% Asian American, 3.7% Latin American, 2.6% African-American, 15.8% other ethnicities).

Materials and procedure

Prior to attending the lab, participants completed a number of online questionnaires including the ERQ (Gross & John, 2003).[4] Upon arrival at the lab, participants were randomly assigned into pairs, ensuring that the women in each pair did

[4] Results did not differ when including ERQ scores as covariates in our main analyses.

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not know each other. The experiment began with participants being fitted with physiological sensors, completing a paced-breathing task and watching a neutral film. These tasks were not analysed for the purpose of the current study (for details, see Butler et al., 2006).

Negative emotion induction and conversation. Next, participants watched a film about the bombing of Hiroshima and Nagasaki, which has been shown to induce intense negative emotions (Butler et al., 2003, 2006). Participants could not see their interaction partner while viewing the film. Next, participants were seated facing their interaction partner and instructed to discuss what they were feeling and thinking during the film, as well as the film's political and religious implications. Participants freely decided when to stop their conversations, which ranged in length from approximately 2–15 minutes ($M = 9.22$, $SD = 3.22$). Conversations were video recorded using two obscured cameras pointing at each participant's face and upper body.

Experimental manipulation of reappraisal and suppression. After viewing the film but before having the conversation, each pair was randomly assigned to the reappraisal group (26 pairs), the suppression group (33 pairs) or the uninstructed control group (36 pairs). In each of the reappraisal and suppression pairs, one woman was randomly assigned to regulate her emotions during the conversation, unbeknownst to her partner. Participants instructed to regulate their emotions using reappraisal were told "to try to look on the bright side", and "to try to find anything positive you can in the film or the conversation". Participants instructed to suppress their emotions were asked "to try to behave in such a way that your partner does not know that you're feeling anything at all", and "to try not to show any emotion in your face or your voice". All other participants were told to "try to interact normally" during the conversation.

Subjective experience of emotion. Similar to Study 1, video-mediated recall was used to assess participants' subjective feelings continuously during the conversation (Gottman & Levenson, 1985). While watching the videotape of their own conversation, participants rated how they felt at each moment of the discussion using a 180° bipolar rating dial with the extreme positions labelled "negative" and "positive" and the middle position labelled "neutral". Prior to the rating dial task, a member of the research team demonstrated how to use the dial and informed participants to continuously rate how they remembered feeling during their conversation. Participants were asked to use the full range of the dial and to rate their emotions relative to the conversation (not their entire lifetime). The rating dial provided a continuous measure of emotional experience (negative to positive) in second-by-second increments with scores ranging from −2.50 (*negative*) through 0 (*neutral*) to +2.50 (*positive*).

Coding of behavioural expression of emotion

Similar to Study 1, videos of the conversations were viewed by trained observers (blind to experimental conditions and hypotheses) who coded participants' positive and negative verbal and non-verbal emotion-expressive behaviours, second-by-second, using custom designed software (CodeBlue, Levenson). Coding was completed using a "cultural informant" approach, in which the gestalt of all simultaneously occurring verbal and non-verbal communicative signals is considered when coding each behavioural segment. Emotional expressions were categorised as being either positive or negative and were scored as either 0 (not present—i.e., neutral expression) or 1 (present). Behavioural codes were not mutually exclusive, implying that a segment could be coded as both positive and negative (as might occur in the context of mixed emotions). Positive behaviours included verbal statements such as "at least the bombs ended the war" and non-verbal signals such as smiling or laughing. Examples of negative behaviours were verbal statements such as "the film was really upsetting" and non-verbal behaviours such as grimaces and frowns. To assess reliability, approximately 60% of the videos were coded by two raters, who achieved excellent inter-rater reliabilities (positive expression: average $r = .90$; negative expression: average $r = .95$).

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HR recording

ECG was recorded using Beckman miniature electrodes in a standard Lead II configuration. The signal was conditioned with an SA Instruments 12-channel bioamplifier and sampled at 400 Hz using a Data Translation 3001 PCI 12-bit 16-channel analogue-to-digital converter. Heart period (HP) was calculated as the interval in milliseconds between successive R-waves after outliers due to artifact or ectopic activity had been corrected or interpolated. HP was converted to HR for analysis using the formula HR=60,000/HP.

Data analyses

Two dyads (one each from the reappraisal and suppression groups) had missing data for all variables due to technical problems. Data for subjective feelings were missing from an additional four dyads (two from the suppression group, and one each from the reappraisal and control groups). Unless otherwise indicated, n = 186 for analyses of the behavioural data, and n = 178 for analyses of the self-reported feelings data. Models were identical to those used in Study 1, with the following three exceptions: first, we initially used three level models to account for the nesting of participants within dyads, but these analyses showed that there was no reliable variance at the dyad level. Furthermore, these models produced essentially the same results as those from a simpler model with the same random structure as in Study 1 and so we report results from the latter.[5] Second, because the behavioural data were binary they were analysed using logistic multilevel models with a log link function at Level-1 (see Appendix). Third, the effects of reappraisal and suppression were modelled at Level-2 using two dummy variables that contrasted participants instructed to use reappraisal (*reappraisers*: n = 25) and suppression (*suppressors*: n = 32), with *uninstructed participants* (i.e., controls and uninstructed partners of reappraisers and suppressors; n = 129). Similar to Study 1, we first conducted preliminary analyses to estimate mean levels and inertia separately for uninstructed participants, suppressors and reappraisers (see Appendix, Models 5 and 6). For our main analyses, we ran models estimating differences in mean levels and inertia among reappraisers and suppressors, compared with uninstructed participants (see Appendix, Models 7 and 8).

Results

Preliminary analyses

Descriptive statistics are shown in Table 3. Mean levels of behaviour are expressed as odds in the column labelled *OR*: e.g., the odds of expressing a negative behaviour during the conversation, among uninstructed participants, was 0.21. When converted to a probability, this implies that a typical uninstructed participant expressed negative emotions during approximately 17% of their conversation. Mean levels of feelings were close to the mid-point of the scale in each group and the mean HR was between 75 and 79 beats per minute in each group. Regarding inertia of behaviours, *OR*s reflect the odds of expressing a behaviour at time t if the behaviour was expressed at time t–5, relative to when the behaviour was not expressed at time t–5. These were >1 in all conditions, implying that participants were more likely to express both positive and negative behaviours at time t if they were also expressed 5 seconds earlier (i.e., behaviours were positively autocorrelated). Similarly, positive inertia estimates for feelings and HR in all conditions indicate that feelings and HR were also positively autocorrelated.

Table 3 also displays correlations between mean levels and inertia of all emotion measures. Correlations between mean levels and emotional inertia within measures were mostly positive. Similarly, correlations between inertia levels across measures were also mostly positive.[6]

[5] Analyses using two-level models with observations crossed with persons at Level-1 and dyads at Level-2 (see e.g., Bolger & Shrout, 2007) also led to the same conclusions as our main analyses.

[6] These correlations were not the main focus of the current report but are provided for descriptive purposes. Given the large number of possible comparisons, we do not report significance tests comparing the strength of correlations between groups.

Table 3. *Descriptive statistics and correlations among mean levels and inertia of experiential, behavioural, and physiological measures of emotion by experimental group in Study 2*

				Correlations						
Measure	*Estimate (SE)*	*95% CI*	*OR*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Uninstructed participants (n = 129)										
Mean level (β_{00})										
1. NEG behaviour	−1.56 (0.05)	[−1.67, −1.45]	0.21	1.00						
2. POS behaviour	−2.51 (0.05)	[−2.62, −2.40]	0.08	.03	1.00					
3. Feelings[a]	−0.17 (0.03)	[−0.23, −0.11]	–	−.17	.14	1.00				
4. HR	76.75 (0.95)	[74.87, 78.63]	–	−.08	.12	−.10	1.00			
Inertia (β_{10})										
5. NEG behaviour	2.02 (0.07)	[1.87, 2.16]	7.51	.13	.23**	.16	−.02	1.00		
6. POS behaviour	1.08 (0.12)	[0.85, 1.30]	2.93	.13	.28**	.07	−.17*	.37***	1.00	
7. Feelings[a]	0.69 (0.02)	[0.66, 0.72]	–	.10	.00	−.13	−.05	.11	.25**	1.00
8. HR	0.29 (0.02)	[0.25, 0.33]	–	.14	−.04	−.02	.16	.25**	.17	.11
Reappraisers (n = 25)										
Mean level (β_{01})										
1. NEG behaviour	−2.57 (0.12)	[−2.82, −2.33]	0.08	1.00						
2. POS behaviour	−1.59 (0.15)	[−1.88, −1.30]	0.20	−.28	1.00					
3. Feelings[b]	0.01 (0.07)	[−0.13, 0.15]	–	.09	−.02	1.00				
4. HR	75.52 (2.18)	[71.23, 79.82]	–	−.18	.56**	.13	1.00			
Inertia (β_{11})										
5. NEG behaviour	1.66 (0.18)	[1.30, 2.02]	5.24	.28	.01	−.45*	−.12	1.00		
6. POS behaviour	1.80 (0.16)	[1.49, 2.11]	6.06	−.14	.48*	−.30	.19	.05	1.00	
7. Feelings[b]	0.71 (0.03)	[0.65, 0.77]	–	.02	.25	−.08	−.06	.11	.38	1.00
8. HR	0.39 (0.04)	[0.30, 0.47]	–	−.19	.36	.21	.55**	−.21	.28	−.02
Suppressors (n = 32)										
Mean level (β_{02})										
1. NEG behaviour	−2.85 (0.20)	[−3.25, −2.45]	0.06	1.00						
2. POS behaviour	−3.50 (0.16)	[−3.81, −3.18]	0.03	.54**	1.00					
3. Feelings[c]	−0.15 (0.10)	[−0.35, 0.04]	–	.46**	.47**	1.00				
4. HR	78.94 (2.05)	[74.89, 82.99]	–	.05	−.03	.03	1.00			
Inertia (β_{12})										
5. NEG behaviour	2.45 (0.18)	[2.10, 2.81]	11.62	.50**	.34	.44*	−.05	1.00		
6. POS behaviour	1.80 (0.32)	[1.16, 2.44]	6.03	.43*	.46**	.39*	−.21	.51**	1.00	
7. Feelings[c]	0.69 (0.03)	[0.62, 0.76]	–	.37*	.11	.25	.14	.46**	.34	1.00
8. HR	0.34 (0.04)	[0.27, 0.42]	–	−.02	−.04	−.14	.08	−.09	.03	.07

Note: SE = standard error; CI = confidence interval; OR = odds ratio (for mean level, *OR* = odds of expressing a positive or negative behaviour). NEG behaviour = binary coded expression of negative emotion. POS behaviour = binary coded expression of positive emotion. Feelings = self-reported experience of emotion on a scale from −2.5 (*negative*) to + 2.5 (*positive*). HR = heart rate (beats per minute). Mean level and inertia estimates are from multilevel models (see Appendix, Models 5 and 6, respectively).

[a] n = 124, due to missing data for self-reported feelings.

[b] n = 24, due to missing data for self-reported feelings.

[c] n = 30, due to missing data for self-reported feelings.

*p < .05; **p < .01; ***p < .001.

Group differences in mean level of emotion

Table 4 displays estimated differences in mean levels of each emotion measure among reappraisers and suppressors relative to uninstructed participants. Reappraisers expressed fewer negative and more positive behaviours and reported lower mean levels of negative feelings than uninstructed participants. In contrast, suppressors displayed

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Table 4. *Differences in mean levels and inertia of motion among reappraisers and suppressors compared with uninstructed participants in Study 2*

	Difference in mean level from uninstructed participants					*Difference in inertia from uninstructed participants*				
Outcome	*Parameter*	*Estimate (SE)*	*95% CI*	*OR*	*p-Value*	*Parameter*	*Estimate (SE)*	*95% CI*	*OR*	*p-Value*
Negative behaviour	Reappraisers (β_{01})	−1.01 (0.13)	[−1.28, −0.75]	0.36	<.001	Reappraisers (β_{11})	−0.36 (0.2)	[−0.75, 0.03]	0.70	.068
	Suppressors (β_{02})	−1.29 (0.21)	[−1.70, −0.88]	0.28	<.001	Suppressors (β_{12})	0.44 (0.19)	[0.06, 0.82]	1.55	.025
Positive behaviour	Reappraisers (β_{01})	0.92 (0.16)	[0.62, 1.23]	2.52	<.001	Reappraisers (β_{11})	0.73 (0.19)	[0.34, 1.11]	2.07	<.001
	Suppressors (β_{02})	−0.99 (0.17)	[−1.32, −0.65]	0.37	<.001	Suppressors (β_{12})	0.72 (0.34)	[0.04, 1.40]	2.06	.037
Feelings[a]	Reappraisers (β_{01})	0.18 (0.08)	[0.03, 0.33]	–	.022	Reappraisers (β_{11})	0.02 (0.03)	[−0.04, 0.09]	–	.496
	Suppressors (β_{02})	0.02 (0.10)	[−0.19, 0.22]	–	.872	Suppressors (β_{12})	0.00 (0.04)	[−0.07, 0.07]	–	1.00
Heart rate	Reappraisers (β_{01})	−1.23 (2.38)	[−5.92, 3.46]	–	.606	Reappraisers (β_{11})	0.10 (0.05)	[0, 0.19]	–	.049
	Suppressors (β_{02})	2.19 (2.26)	[−2.27, 6.66]	–	.334	Suppressors (β_{12})	0.05 (0.04)	[−0.03, 0.14]	–	.219

Note: OR = odds ratio; CI = confidence interval.
Estimated differences in mean level (β_{01} and β_{02}) are from Model 7 (see Appendix). Estimated differences in inertia (β_{11} and β_{12}) are from Model 8 (see Appendix).
Approximate *d.f.* = 183 for all analyses with negative behaviour, positive behaviour and heart rate as outcomes.
[a]Approximate *d.f.* = 175 due to missing data.

fewer negative and positive behaviours but did not differ from uninstructed participants in their mean level of feelings. No group differences were found for mean levels of HR. Follow-up analyses directly comparing reappraisers and suppressors on mean levels of emotion revealed that reappraisers expressed significantly more positive behaviour than suppressors (p<.001), but did not differ on mean levels of negative behaviour, feelings or HR (all ps>18).

Group differences in emotional inertia

Estimated differences in emotional inertia among reappraisers and suppressors relative to uninstructed participants are shown in Table 4. Neither instructed reappraisers nor suppressors showed differences in the autocorrelation (inertia) of their subjective feelings. However, as predicted, and consistent with our findings in Study 1, suppressors showed significantly higher inertia of negative behaviours. Specifically, compared with uninstructed participants, suppressors had 55% higher odds of expressing a negative behaviour at any moment if they had also displayed a negative behaviour 5 seconds earlier (for inertia estimates in each group, see Table 3). In contrast, participants instructed to reappraise displayed lower inertia of negative behaviours, compared to uninstructed participants, although this effect did not reach conventional levels of statistical significance (p=.068). Specifically, among instructed reappraisers, the odds ratio reflecting inertia of negative behaviours was 30% lower than the equivalent odds ratio for uninstructed participants. For inertia of positive behaviours, we found that both reappraisers and suppressors showed higher inertia than uninstructed participants: the odds of displaying a positive behaviour at time t given that a positive behaviour was observed at time t–5 were 107% higher among reappraisers and 106% higher among suppressors, relative to uninstructed participants (for inertia estimates in each group, see Table 3). Similar to the results for positive behaviours, reappraisers displayed higher HR inertia than uninstructed participants. In contrast,

however, suppressors did not differ in their HR inertia compared with uninstructed participants.

Follow-up analyses directly comparing inertia levels among reappraisers and suppressors revealed that inertia of negative behaviours was significantly higher among suppressors than reappraisers (p = .002), whereas suppressors and reappraisers did not differ significantly in the inertia of positive behaviours (p = .988), feelings (p = .616) or HR (p = .480).

Discussion

Replicating the findings of Study 1, instructed suppression was related to higher inertia of negative emotional behaviours. This experimental evidence suggests that suppression is causally related to higher inertia of negative behaviours. We also found weak evidence for an effect of reappraisal on reducing the inertia of negative behaviours. However, as this result was only marginally significant and not consistent across studies, it should be interpreted with caution. Also in line with Study 1, we found no effects of instructed reappraisal or suppression on the inertia of subjective feelings.

Regarding the effects of emotion regulation on the inertia of positive emotions, we found that both reappraisal and suppression resulted in higher inertia of positive behaviours. Thus, while suppression appears to increase inertia of both negative and positive emotions, the effects of reappraisal were valence specific. Supporting this conclusion, the association between inertia of negative and positive behaviours was stronger among suppressors than among reappraisers (see Table 3). Our finding that reappraisal increased the inertia of positive behaviours appears to be at odds with the notion that, on one hand, reappraisal is an adaptive and flexible regulation strategy (Gross & Thompson, 2007) while on the other hand, inertia is a hallmark of dysregulated and inflexible emotion dynamics (Butler, 2011; Kuppens, Allen et al., 2010). However, displaying relatively stable levels of positive emotions may be adaptive under certain circumstances (Höhn et al., 2013; Gruber et al., 2013), perhaps especially when combined with higher mean levels of positive emotions. In the current study, reappraisers displayed significantly higher mean levels of positive behaviours in addition to showing elevated inertia of positive behaviours (see Table 4). In contrast, previous findings linking higher inertia of positive emotions with reduced well-being have been in the context of lower mean levels of positive emotions (Kuppens, Allen et al., 2010; Kuppens et al., 2012), similar to what we observed among suppressors in the current study (see Table 4). Thus, the combination of mean level and autocorrelation may be crucial for differentiating between adaptive and maladaptive functioning, particularly for positive emotions.

In line with our findings in Study 1, suppression was unrelated to HR inertia. However, reappraisers displayed higher HR inertia than uninstructed participants. Finally, similar to our findings in Study 1, we found mostly small positive correlations between inertia levels across the different emotion measures.

GENERAL DISCUSSION

The current studies were the first to examine how suppression and reappraisal relate to emotional inertia. In doing so, these studies address two important issues. First, given that emotional inertia has been identified as potential early warning signal for clinical depression (van de Leemput et al., 2014), understanding the processes that underlie inertia may help to prevent the onset of affective dysfunction. Second, although emotion regulation is commonly assumed to influence the temporal dynamics of emotions (see e.g., Gross & Thompson, 2007), few studies have tested this assumption.

As predicted, we found consistent evidence across studies that expressive suppression was related to higher inertia of negative emotional behaviours. In contrast, reappraisal was not related to lower inertia of negative behaviours in Study 1, and only weakly in Study 2. Thus, while both habitual and instructed suppression appear to be associated with increased inertia of negative behaviours, the predicted effects of reappraisal were not

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borne out. Neither reappraisal nor suppression were related to the inertia of subjective feelings in either study. Exploratory analyses examining HR inertia revealed no significant effects of suppression, and inconsistent findings for reappraisal, which was only related to higher HR inertia in Study 2. Finally, exploratory analyses in Study 2 showed that both suppression and reappraisal were related to higher inertia of positive emotional behaviour.

Divergence in results for experiential and behavioural components of emotion

Our failure to find the predicted effects of reappraisal and suppression on experiential inertia suggest a number of possible underlying mechanisms. Suppression is a response-focused regulation strategy, which does not reliably influence the (mean) level of subjective feelings (Webb et al., 2012), and may similarly have no impact on the dynamics of feelings (cf. Dan-Glauser & Gross, 2011). Yet, the findings for reappraisal are more puzzling, given that it is an antecedent-focused regulation strategy that theoretically interrupts the emotion-generative sequence as it arises (Gross & Thompson, 2007). One possibility is that our findings for experiential inertia relate to how feelings were assessed in the current studies (i.e., using video-mediated recall, in a lab context, on a shorter timescale, using a bipolar rating scale). However, another possibility is that reappraisal may only influence certain specific features of an emotional trajectory (e.g., recovery time) and not others (e.g., rise time to peak; see Davidson, 1998). As a result, reappraisal may not have a pronounced effect on emotional inertia (as captured by an autocorrelation), as this is a more global measure of emotion dynamics that encompasses both emotional reactivity and recovery (see Kuppens, Allen et al., 2010).

Implications of the current studies

The current findings have a number of implications for research on emotion regulation, both in general and specifically in relation to emotional inertia. First, the current studies demonstrate that suppression and reappraisal have distinguishable effects on the temporal dynamics of emotions, complementing previous studies that have focused largely on the effects of each strategy on emotional intensity. Second, in line with previous theoretical and empirical work (e.g., Butler et al., 2003; Gross & Thompson, 2007), our findings suggest that suppression may be maladaptive to the extent that it increases the predictability of emotional behaviours, thereby undermining the capacity for flexible emotional responding. This may occur because suppression necessarily reduces the repertoire of possible behaviours a person can express in a given situation to those that are relatively non-emotional.[7] While expressive suppression may not always be detrimental (e.g., Bonanno et al., 2004), when suppression is habitual, and especially when it is not part of a broader repertoire of emotion regulation strategies, it may confer increased risk for psychopathology (Aldao et al., 2010; Loughead & Hollenstein, 2012). Third, the current studies begin to shed light on the possible mechanisms underlying the association between emotional inertia and low well-being. For instance, the association between depression and higher emotional inertia may be driven by the tendency for currently depressed or depression-prone individuals to use suppression when attempting to down-regulate their negative emotions (e.g., Ehring, Tuschen-Caffier, Schnülle, Fischer, & Gross, 2010).

Limitations and directions for future research

A first limitation of the current studies is that feelings were assessed using video-mediated recall, which relies on retrospective recall and therefore may not reliably capture moment-to-moment fluctuations in feelings. Furthermore, video recall may inflate associations between reported feelings and expressed behaviours as participants rate their feelings while watching their own behaviour. An

[7] We thank an anonymous reviewer for suggesting this explanation.

important direction for future studies on emotional inertia is to assess feelings in real-time without relying on retrospective recall.

Second, while the tasks used to elicit emotions in both studies were more naturalistic than the emotion inductions used in most previous research on emotion regulation (e.g., emotional pictures or film-clips), they remain somewhat removed from emotional encounters in daily life. Examining how emotion regulation impacts the temporal unfolding of emotions in daily life, and in real-time, represents a major methodological challenge. Yet recent advances in ambulatory assessment technologies make this a realistic goal for future studies (Trull & Ebner-Priemer, 2013).

Third, the samples used in both studies were limited in terms of age range, educational status and gender (Study 2). Future studies are needed to investigate the effects of emotion regulation on emotion dynamics in general community samples, as well as among individuals with various psychopathologies.

Finally, while suppression and reappraisal are among the most widely studied emotion regulation strategies, other forms of emotion regulation may have more pronounced effects on emotional inertia. For instance, engaging in rumination might be expected to increase inertia, whereas using distraction may decrease emotional inertia. While trait rumination has been shown to correlate positively with emotional inertia (Koval et al., 2012), experimental evidence is still lacking.

Conclusion

Although emotion regulation is assumed to influence the way emotions unfold across time (Gross & Thompson, 2007), the current studies are among the few to have tested this empirically. In particular, although emotional inertia has become recognised as a central feature of emotion dynamics and important predictor of well-being (Butler, 2011; Hollenstein et al., 2013; Houben et al., 2014), little is known about its determinants. The current studies demonstrate that how people regulate their emotions may contribute to individual differences in emotional inertia. While the studies reported here are merely a first step, our hope is that future research will build on the current findings to develop a comprehensive understanding of the processes involved in various patterns of emotion dynamics.

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REFERENCES

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

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion regulation strategies and psychopathology: A meta-analysis. *Clinical Psychology Review*, *30*, 217–237. doi:10.1016/j.cpr.2009.11.004

Allen, N. B., & Sheeber, L. B. (2008). The importance of affective development for the emergence of depressive disorder during adolescence. In N. B. Allen & L. B. Sheeber (Eds.), *Adolescent emotional development and the emergence of depressive disorders* (pp. 1–10). Cambridge: Cambridge University Press.

Bolger, N., & Shrout, P. E. (2007). Accounting for statistical dependency in longitudinal data on dyads. In T. D. Little, J. A. Bovaird, & N. A. Card (Eds.), *Modeling contextual effects in longitudinal studies* (pp. 285–298). Mahwah, NJ: Erlbaum.

Bonanno, G. A., Papa, A., Lalande, K., Westphal, M., & Coifman, K. (2004). The importance of being flexible: The ability to enhance and suppress emotional expression predicts long-term adjustment. *Psychological Science*, *157*, 482–487. doi:10.1111/j.0956-7976.2004.00705.x

Brans, K., Koval, P., Verduyn, P., Lim, Y. L., & Kuppens, P. (2013). The regulation of negative and positive affect in daily life. *Emotion*, *13*, 926–939. doi:10.1037/a0032400

Buss, K. A., & Goldsmith, H. H. (1998). Fear and anger regulation in infancy: Effects on the temporal dynamics of affective expression. *Child Development*, *69*, 359–374. doi:10.1111/j.1467-8624.1998.tb06195.x

Butler, E. A. (2011). Temporal interpersonal emotion systems: The "TIES" that form relationships. *Personality and Social Psychology Review*, *15*, 367–393. doi:10.1177/1088868311411164

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Butler, E. A., Egloff, B., Wilhelm, F. H., Smith, N. C., Erickson, E. A., & Gross, J. J. (2003). The social consequences of expressive suppression. *Emotion*, *3*, 48–67. doi:10.1037/1528-3542.3.1.48

Butler, E. A., Wilhelm, F. H., & Gross, J. J. (2006). Respiratory sinus arrhythmia, emotion, and emotion regulation during social interaction. *Psychophysiology*, *43*, 612–622. doi:10.1111/j.1469-8986.2006.00467.x

Cole, P. M., Marin, S. E., & Dennis, T. A. (2004). Emotion regulation as a scientific construct: Methodological challenges and directions for child development research. *Child Development*, *75*, 317–333. doi:10.1111/j.1467-8624.2004.00673.x

Dan-Glauser, E. S., & Gross, J. J. (2011). The temporal dynamics of two response-focused forms of emotion regulation: Experiential, expressive, and autonomic consequences. *Psychophysiology*, *48*, 1309–1322. doi:10.1111/j.1469-8986.2011.01191.x

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition and Emotion*, *12*, 307–320. doi:10.1080/026999398379628

Ebner-Priemer, U. W., Kuo, J., Kleindienst, N., Welch, S. S., Reisch, T., Reinhard, I., & Bohus, M. (2007). State affective instability in borderline personality disorder assessed by ambulatory monitoring. *Psychological Medicine*, *37*, 961–970. doi:10.1017/S0033291706009706

Egloff, B., Schmukle, S. C., Burns, L. R., & Schwerdtfeger, A. (2006). Spontaneous emotion regulation during evaluated speaking tasks: Associations with negative affect, anxiety expression, memory, and physiological responding. *Emotion*, *6*, 356–366. doi:10.1037/1528-3542.6.3.356

Ehring, T., Tuschen-Caffier, B., Schnülle, J., Fischer, S., & Gross, J. J. (2010). Emotion regulation and vulnerability to depression: Spontaneous versus instructed use of emotion suppression and reappraisal. *Emotion*, *10*, 563–572. doi:10.1037/a0019010

Erk, S., Mikschel, A., Stier, S., Ciaramidaro, A., Gapp, V., Weber, B., & Walter, H. (2010). Acute and sustained effects of cognitive emotion regulation in major depression. *Journal of Neuroscience*, *30*, 15726–15734. doi:10.1523/JNEUROSCI.1856-10.2010

Farmer, A. S., & Kashdan, T. (2014). Affective and self-esteem instability in the daily lives of people with generalized social anxiety disorder. *Clinical Psychological Science*, *2*, 187–201. doi:10.1177/2167702613495200

Frijda, N. H. (2007). *The laws of emotion*. Mahwah, NJ: Erlbaum.

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry*, *63*, 577–586. doi:10.1016/j.biopsych.2007.05.031

Gottman, J. M., & Levenson, R.W. (1985). A valid procedure for obtaining self-report of affect in marital interaction. *Journal of Consulting and Clinical Psychology*, *53*, 151–160. doi:10.1037/0022-006X.53.2.151

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

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology*, *39*, 281–291.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, *85*, 348–362. doi:10.1037/0022-3514.85.2.348

Gross, J. J., & Munoz, R. F. (1995). Emotion regulation and mental health. *Clinical Psychology: Science and Practice*, *2*, 151–164. doi:10.1111/j.1468-2850.1995.tb00036.x

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3–24). New York, NY: Guilford Press.

Gruber, J., Kogan, A., Quoidbach, J., & Mauss, I. B. (2013). Happiness is best kept stable: Positive emotion variability is associated with poorer psychological health. *Emotion*, *13*, 1–6. doi:10.1037/a0030262

Hamaker, E. L. (2012). Why researchers should think "within-person": A paradigmatic rationale. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 43–61). New York, NY: Guilford.

Hoeksma, J. B., Oosterlaan, J., & Schipper, E. M. (2004). Emotion regulation and the dynamics of feelings: A conceptual and methodological framework. *Child Development*, *75*, 354–360. doi:10.1111/j.1467-8624.2004.00677.x

Höhn, P., Menne-Lothmann, C., Peeters, F., Nicolson, N. A., Jacobs, N., Derom, C., … Wichers, M. (2013). Moment-to-moment transfer of positive emotions in daily life predicts future course of depression in both general population and patient samples. *PLoS ONE*, *8*, e75655. doi:10.1371/journal.pone.0075655

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Hollenstein, T., Lichtwarck-Aschoff, A., & Potworowski, G. (2013). A model of socioemotional flexibility at three time scales. *Emotion Review*, *5*, 397–405. doi:10.1177/1754073913484181

Hollenstein, T., & Lougheed, J. P. (2013). Beyond storm and stress: Typicality, transactions, timing, and temperament to account for adolescent change. *American Psychologist*, *68*, 444–454. doi:10.1037/a0033586

Houben, M., Van Den Noortgate, W., & Kuppens, P. (2014). *The relation between patterns of emotional change and psychological well-being: A meta-analysis*. Manuscript submitted for publication.

Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical Psychology Review*, *30*, 865–878. doi:10.1016/j.cpr.2010.03.001

Koole, S. (2009). The psychology of emotion regulation: An integrative review. *Cognition & Emotion*, *23*, 4–41. doi:10.1080/02699930802619031

Koval, P., Kuppens, P., Allen, N. B., & Sheeber, L. B. (2012). Getting stuck in depression: The roles of rumination and emotional inertia. *Cognition & Emotion*, *26*, 1412–1427. doi:10.1080/02699931.2012.667392

Koval, P., Pe, M. L., Meers, K., & Kuppens, P. (2013). Affect dynamics in relation to depressive symptoms: Variable, unstable or inert?*Emotion*, *13*, 1132–1141. doi:10.1037/a0033579

Kuppens, P., Allen, N. B., & Sheeber, L. (2010). Emotional inertia and psychological maladjustment. *Psychological Science*, *21*, 984–991. doi:10.1177/0956797610372634

Kuppens, P., Oravecz, Z., & Tuerlinckx, F. (2010). Feelings change: Accounting for individual differences in the temporal dynamics of affect. *Journal of Personality and Social Psychology*, *99*, 1042–1060. doi:10.1037/a0020962

Kuppens, P., Sheeber, L. B., Yap, M. B., Whittle, S., Simmons, J. G., & Allen, N. B. (2012). Emotional inertia prospectively predicts the onset of depressive disorder in adolescence. *Emotion*, *12*, 283–289. doi:10.1037/a0025046

Lanteigne, D., Glozman, J., & Hollenstein, T. (2010). *Self-conscious affect coding manual*. Unpublished Coding Manual.

Lougheed, J. P., & Hollenstein, T. (2012). A limited repertoire of emotion regulation strategies is associated with internalizing problems in adolescence. *Social Development*, *21*, 704–721. doi:10.1111/j.1467-9507.2012.00663.x

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*, 400–424. doi:10.1111/j.1745-6924.2008.00088.x

Rhode, P., Lewinsohn, P. M., Klein, D. N., Seeley, J. R., & Gau, J. M. (2013). Key characteristics of major depressive disorder in childhood, adolescence, emerging adulthood, and adulthood. *Clinical Psychological Science*, *1*, 41–53. doi:10.1177/2167702612457599

Richards, J. M., & Gross, J. J. (2000). Emotion regulation and memory: The cognitive costs of keeping one's cool. *Journal of Personality and Social Psychology*, *79*, 410–424. doi:10.1037/0022-3514.79.3.410

Ruef, A. M., & Levenson, R. W. (2007). Continuous measurement of emotion. In J. A. Coan & J. J. B. Allen (Eds.), *The handbook of emotion elicitation and assessment* (pp. 286–297). New York, NY: Oxford University Press.

Salters-Pednault, K., Steenkamp, M., & Litz, B. T. (2010). Suppression. In A. M. Kring & D. M. Sloan (Eds.), *Emotion regulation and psychopathology: A transdiagnostic approach to etiology and treatment* (pp. 137–156). New York, NY: Guilford.

Schmeichel, B. J., Volokhov, R. N., & Demaree, H. A. (2008). Working memory capacity and the self-regulation of emotional expression and experience. *Journal of Personality and Social Psychology*, *95*, 1526–1540. doi:10.1037/a0013345

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). London: Sage.

Suls, J., & Martin, R. (2005). The daily life of the garden-variety neurotic: Reactivity, stressor exposure, mood spillover, and maladaptive coping. *Journal of Personality*, *73*, 1485–1510. doi:10.1111/j.1467-6494.2005.00356.x

Suls, J., Green, P., & Hillis, S. (1998). Emotional reactivity to everyday problems, affective inertia, and neuroticism. *Personality and Social Psychology Bulletin*, *24*, 127–136. doi:10.1177/0146167298242002

Thompson, R. A. (1990). Emotion and self-regulation. In R. A. Thompson (Ed.), *Socioemotional development. Nebraska symposium on motivation* (Vol. 36, pp. 367–467). Lincoln: University of Nebraska Press.

Thompson, R. J., Mata, J., Jaeggi, S., Buschkuehl, M., Jonides, J., & Gotlib, I. H. (2012). The everyday emotional experiences of individuals with major depressive disorder: Examining emotional instability, inertia, and reactivity. *Journal of Abnormal Psychology*, *121*, 819–829. doi:10.1037/a0027978

Totterdell, P., & Holman, D. (2003). Emotion regulation in customer service roles: Testing a model of emotional labor. *Journal of Occupational Health Psychology*, *8*, 55–73. doi:10.1037/1076-8998.8.1.55

Trull, T. J., & Ebner-Priemer, U. (2013). Ambulatory assessment. *Annual Review of Clinical Psychology*, *9*, 151–176. doi:10.1146/annurev-clinpsy-050212-185510

van de Leemput, I. A., Wichers, M., Cramer, A. O., Borsboom, D., Tuerlinckx, F., Kuppens, P., … & Scheffer, M. (2014). Critical slowing down as early warning for the onset and termination of depression. *Proceedings of the National Academy of Sciences*, *111*, 87–92. doi:10.1073/pnas.1312114110

Verduyn, P., Delvaux, E., Van Coillie, H., Tuerlinckx, F., & Van Mechelen, I. (2009). Predicting the duration of emotional experience: Two experience sampling studies. *Emotion*, *9*, 83–91. doi:10.1037/a0014610

Verduyn, P., Van Mechelen, I., & Tuerlinckx, F. (2011). The relation between event processing and the duration of emotional experience. *Emotion*, *11*, 20–28. doi:10.1037/a0021239

Walter, H., von Kalckreuth, A., Schardt, D., Stephan, A., Goschke, T., & Erk, S. (2009). The temporal dynamics of voluntary emotion regulation. *PLoS one*, *4*, e6726. doi:10.1371/journal.pone.0006726

Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin*, *138*, 775–808. doi:10.1037/a0027600

Wichers, M. (2014). The dynamic nature of depression: A new micro-level perspective of mental disorder that meets current challenges. *Psychological medicine*, *44*, 1349–1360. doi:10.1017/S0033291713001979

Zelazo, P. D., & Cunningham, W. A. (2007). Executive function: Mechanisms underlying emotion regulation. In J. J. Gross (Ed.) *Handbook of emotion regulation* (pp. 542–559). New York, NY: Guilford.

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APPENDIX

Study 1 (preliminary analyses)

Model 1: mean levels of emotion. To estimate mean levels of each emotion measure across the sample, we ran models in which the outcome at Level-1 (Emotion_{tj}), representing person j's level of emotion at time t, was modelled as a function of a within-person intercept (π_{0j}), reflecting person j's mean level of emotion across all observations, and a residual term (e_{tj}), representing how much person j's emotion level at time t deviates from their mean level of emotion (see Equation 1a). At Level-2, the within-person intercept was modelled as a function of a between-person intercept (β_{00}), representing the grand mean level of emotion across the sample, and a between-person residual term (r_{0j}), representing how much each person j's mean level of emotion deviates from the grand mean (see Equation 1b). Mean levels reported in Table 1 are β_{00} estimates and their associated *SE*s and 95% CIs:

$$\text{Level-1 (observations): } \text{Emotion}_{tj} = \pi_{0j} + e_{tj} \quad (1a)$$

$$\text{Level-2 (persons): } \pi_{0j} = \beta_{00} + r_{0j} \quad (1b)$$

Model 2: emotional inertia. To estimate emotional inertia for each emotion measure across the sample, we ran models in which the outcome at Level-1 (Emotion_{tj}) is modelled as a function of an intercept (π_{0j}), and a within-person autoregressive slope (π_{1j}), reflecting the association between person j's level of emotion at time t–5 (Emotion_{t-5j}) and their level of emotion at time t (see Equation 2a). This autoregressive slope represents a person j's level of emotional inertia. We used a lag of 5 seconds as this corresponds closely to the duration of a turn of speech (Gottman et al., 2005)[8] and is consistent with previous studies on emotional inertia based on similar second-by-second data (Koval et al., 2012; Kuppens, Allen et al., 2010; Kuppens et al., 2012). To allow for an interpretation of within-person effects, the lagged predictor (Emotion_{t-5j}) was person-mean-centered. At Level-2, β_{10} represents the average autoregressive slope (i.e., inertia) across the sample, and r_{1j} represents how much each person j's autoregressive slope deviates from the sample average (see Equation 2b). Inertia levels for each measure reported in Table 1 are β_{10} estimates and their associated *SE*s and 95% CIs:

$$\text{Level-1 (observations): } \text{Emotion}_{tj} = \pi_{0j} + \pi_{1j}\,(\text{Emotion}_{t-5j}) + e_{tj} \quad (2a)$$

$$\text{Level-2 (persons): } \pi_{0j} = \beta_{00} + r_{0j}, \quad \pi_{1j} = \beta_{10} + r_{1j} \quad (2b)$$

Correlations between mean levels and inertia. To calculate correlations between mean levels and inertia of each emotion measure across the sample, we extracted π_{0j} estimates (representing each person j's mean level of emotion, taken from Model 1) and π_{1j} estimates (representing each person j's level of inertia, taken from Model 2). We then calculated Pearson correlations using these person-specific estimates, which are reported in Table 1.

[8] We repeated our main analyses in both Study 1 and Study 2 using a lag of 10 seconds and found highly similar results.

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Study 1 (main analyses)

Model 3: associations between reappraisal and suppression with mean levels of emotion. To estimate how strongly trait reappraisal and suppression were associated with mean levels of emotion, we ran models in which the Level-1 equation was the same as in Model 1 (see Equation 3a). However, at Level-2, variation across persons in the Level-1 intercepts was modelled as a function of standardized reappraisal (zReap) and suppression (zSupr) scores (see Equation 3b). Thus, the parameters β_{01} and β_{02} are standardized regression coefficients representing associations between mean levels of emotion and trait reappraisal and suppression, respectively. Estimates of these parameters and their associated *SE*s and 95% CIs are reported in Table 2:

$$\text{Level-1 (observations): Emotion}_{tj} = \pi_{0j} + \text{e}_{tj} \quad (3a)$$

$$\text{Level-2 (persons): } \pi_{0j} = \beta_{00} + \beta_{01}(\text{zReap}_j) + \beta_{02}(\text{zSupr}_j) + r_{0j} \quad (3b)$$

Model 4: associations between reappraisal and suppression with emotional inertia. To test our main hypotheses regarding how strongly emotional inertia is associated with trait reappraisal and suppression, we ran models in which the Level-1 equation was the same as in Model 2 (see Equation 4a). However, at Level-2, variation across persons in the Level-1 autoregressive slopes was modelled as a function of standardized trait reappraisal (zReap) and suppression (zSupr) scores (see Equation 4b). Thus, the Level-2 parameters β_{11} and β_{12} are standardized regression coefficients representing the associations between inertia and trait reappraisal and suppression, respectively. Estimates of these parameters and their associated *SE*s and 95% CIs are reported in Table 2:

$$\text{Level-1 (observations): Emotion}_{tj} = \pi_{0j} + \pi_{1j}(\text{Emotion}_{t-5j}) + \text{e}_{tj} \quad (4a)$$

$$\begin{aligned}\text{Level-2 (persons): } \pi_{0j} &= \beta_{00} + \beta_{01}(\text{zReap}_j) + \beta_{02}(\text{zSupr}_j) + r_{0j} \\ \pi_{1j} &= \beta_{10} + \beta_{11}(\text{zReap}_j) + \beta_{12}(\text{zSupr}_j) + r_{1j}\end{aligned} \quad (4b)$$

Study 2 (preliminary analyses)

Model 5: mean levels of emotion. To estimate mean levels of emotion separately for each group (uninstructed participants, reappraisers and suppressors), we ran models in which the outcome[9] at Level-1 (Emotion_{tj}) was modelled as a function of a within-person intercept (π_{0j}), representing each person j's mean level of emotion (see Equation 5a). We did not include a general intercept at Level-2, but instead included three binary predictors (Uninstr_j, Reap_j and Supr_j: 1 = yes, 0 = no), indicating whether each person j was randomly assigned to the uninstructed, reappraiser or suppressor groups (see Equation 5b). Thus, the Level-2 parameters β_{00}, β_{01} and β_{02} represent mean levels of emotion, separately for uninstructed participants, reappraisers and suppressors, respectively. Estimates of these parameters and their associated *SE*s and 95% CIs are reported as mean levels in Table 3:

$$\text{Level-1 (observations): Emotion}_{tj} = \pi_{0j} + \text{e}_{tj} \quad (5a)$$

$$\text{Level-2 (persons): } \pi_{0j} = \beta_{00}(\text{Uninstr}_j) + \beta_{01}(\text{Reap}_j) + \beta_{02}(\text{Supr}_j) + r_{0j} \quad (5b)$$

Model 6: emotional inertia. To estimate emotional inertia separately for each group (uninstructed participants, reappraisers, and suppressors), we ran models in which the outcome (footnote 9) at Level-1 (Emotion_{tj}) was modelled as a function of an intercept (π_{0j}), and a within-person autoregressive slope (π_{1j}), reflecting the association between person j's level of emotion at time t–5 (Emotion_{t-5j}) and their level of emotion at time t (see Equation 6a). We did not include general intercepts at Level-2, but instead added three binary predictors (Uninstr_j, Reap_j and Supr_j: 1 = yes, 0 = no), indicating whether each person j was randomly assigned to the uninstructed, reappraiser or suppressor groups (see Equation 6b). Thus, the Level-2 parameters β_{10}, β_{11} and β_{12} represent emotional inertia levels, separately for uninstructed participants, reappraisers and suppressors, respectively. Estimates of these parameters and their associated *SE*s and 95% CIs are reported as inertia levels in Table 3:

$$\text{Level-1 (observations): Emotion}_{tj} = \pi_{0j} + \pi_{1j}(\text{Emotion}_{t-5j}) + e_{tj} \quad (6a)$$

$$\begin{aligned}\text{Level-2 (persons): } \pi_{0j} &= \beta_{00}(\text{Uninstr}_j) + \beta_{01}(\text{Reap}_j) + \beta_{02}(\text{Supr}_j) + r_{0j} \\ \pi_{1j} &= \beta_{10}(\text{Uninstr}_j) + \beta_{11}(\text{Reap}_j)' + \beta_{12}(\text{Supr}_j) + r_{1j}\end{aligned} \quad (6b)$$

[9] In Study 2, behavioural expressions of negative and positive emotions were assessed using binary codes (i.e., 1 = present, 0 = absent). We therefore analysed behavioural data using logistic multilevel models, in which a log-link function was added to the Level-1 equation. However, for simplicity, we only present model equations for continuous outcomes (see Models 5–8).

Correlations between mean levels and inertia. Correlations between mean levels and inertia of each emotion measure were calculated by extracting π_{0j} estimates from Model 5 (representing each person j's mean level) and π_{1j} estimates from Model 6 (representing each person j's level of inertia) for each emotion measure. Pearson correlations were calculated separately for each group using these person-specific estimates, and are reported in Table 3.

Study 2 (main analyses)

Model 7: group differences in mean levels of emotion. We estimated group differences in mean levels of emotion using models that were very similar to those described in Model 5. However, instead of three binary predictors at Level-2, we included a general intercept and two binary predictors (Supr_j and Reap_j: 1 = yes, 0 = no) indicating whether each person j was instructed to use suppression or reappraisal. Thus, the intercept at Level-2 (β_{00}) represents the mean level of emotion for the reference category (i.e., uninstructed participants), while the Level-2 slopes (β_{01} and β_{02}) reflect differences in mean levels of emotion among reappraisers and suppressors, respectively, compared with uninstructed participants (see Equation 7b). Estimates of β_{01} and β_{02} along with their associated *SE*s and 95% CIs are reported in Table 4:

$$\text{Level-1 (observations):}\quad \text{Emotion}_{tj} = \pi_{0j} + e_{tj} \tag{7a}$$

$$\text{Level-2 (persons):}\quad \pi_{0j} = \beta_{00} + \beta_{01}\,(\text{Reap}_j) + \beta_{02}\,(\text{Supr}_j) + r_{0j} \tag{7b}$$

Model 8: group differences in emotional inertia. We tested our main hypotheses regarding the effects of instructed suppression and reappraisal on emotional inertia using models very similar to those described in Model 6. However, instead of three binary predictors at Level-2, we included a general intercept and two binary predictors (Supr_j and Reap_j: 1 = yes, 0 = no) indicating whether each person j was instructed to use suppression (Supr) or reappraisal (Reap). Thus, the Level-2 intercept (β_{10}) represents emotional inertia for the reference category (i.e., uninstructed participants) while the Level-2 slopes (β_{11} and β_{12}) reflect differences in emotional inertia among reappraisers and suppressors, respectively, compared with uninstructed participants (see Equation 8b). Estimates of β_{11} and β_{12} along with their associated *SE*s and 95% CIs are reported in Table 4:

$$\text{Level-1 (observations):}\ \text{Emotion}_{tj} = \pi_{0j} + \pi_{1j}\,(\text{Emotion}_{t-5j}) + e_{tj} \tag{8a}$$

$$\text{Level-2 (persons):}\quad \pi_{0j} = \beta_{00} + \beta_{01}\,(\text{Reap}_j) + \beta_{02}\,(\text{Supr}_j) + r_{0j}$$
$$\pi_{1j} = \beta_{10} + \beta_{11}\,(\text{Reap}_j) + \beta_{12}\,(\text{Supr}_j) + r_{1j} \tag{8b}$$

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