The Need for Change: Understanding Emotion Regulation Deployment and Consequences Using Ecological Momentary Assessment

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ABSTRACT
In the last decades, Emotion Regulation (ER) represented one of the most studied constructs within the psychological field. Most research, however, has been conducted in laboratory settings; consequently, there are still questions that need to be addressed concerning the deployment and consequences of ER in everyday life. Beyond traditional methods, ecological momentary assessment (EMA) via mobile devices (e.g. smartphones) has the potential to capture ER dynamics during the flow of daily experiences and in real-life settings. Compared to retrospective surveys and laboratory experiments, this approach allows to ecologically and repeatedly investigate the deployment of ER, as well as understand the direct consequences of this process on different aspects of daily life, including behaviors and affect. We will discuss what we currently know about the deployment and consequences of ER in real-life settings focusing on studies that investigated this process by means of EMA. In doing so, we will point out the potentialities of this approach both from a theoretical and clinical point of view.

1. Introduction

Emotion Regulation (ER) constitutes a key process that every individual explicitly or implicitly implements to achieve the multiple goals necessary both to cope with everyday challenges and to achieve personal goals. The whole regulation process is usually divided into stages and strategies, depending on the moment and type of mechanism utilized to downregulate or upregulate a certain emotional state, respectively. In line with the whole study of mental states and processes, ER can be conceptualized as a complex process characterized by physiological underpinnings, behavioral responses, and affective and cognitive correlates.

The first formal definition of ER was drawn twenty years ago in the seminal paper of James Gross (Gross, 1998). Following this, a vast array of researchers have focused their work on the study of ER (Fernández-Álvarez et al., 2018) and developed new conceptualizations of this process, such as the incorporation of interpersonal ER (Zaki & Craig Williams, 2013) or the study of ER implicit dimensions (Gyurak et al., 2011). As a consequence of these new developments, an extended model of the classical one has been brought forth (Gross, 2015). Additionally, complementary theoretical perspectives have emerged, incorporating new key aspects of the information processing conceptualization (Koole & Veenstra, 2015).

Precisely, the study of the context and the role of situated processes constitutes a nodal way in which mental states can be conceptualized. ER is not the exception to the rule, and the preponderant role of situational and contextual variables is increasingly emerging (Aldao, 2013; Doré, Silvers, & Ochsner, 2016). However, so far ER has been mostly investigated in laboratory settings, leaving situated aspects and contextual factors almost understudied. Consequently, there are still questions that need to be addressed concerning the deployment of regulatory strategies in the real world.

2. Ecological Momentary Assessment as a suitable way to study ER dynamics

A different approach to traditional laboratory experiments is represented by ecological momentary assessment (EMA), which emerged as an alternative data capture strategy to episodic, retrospective self-reports. EMA enables repeated input of thoughts, feelings or behaviors which is performed close in time to the experience and in real-life contexts, thus reducing or eliminating the recall bias and allowing for the ecological assessment of individuals' experiences in daily life (García-Palacios et al., 2014; Moskowitz & Young, 2006). Not surprisingly, EMA is considered the gold standard assessment method in health settings (Shiffman, Stone, & Hufford, 2008).

For decades, though, EMA application has been difficult, arguably because of the use of paper diaries, which resulted in low compliance and errors in manual data entry. The past decades, however, have seen a surge in studies using EMA as a result of the increased availability of smartphones and the explosion of mobile applications, which have been successfully used both for subjective (Suso-Ribera et al., 2018) and objective data collection (Mohr, Zhang, & Schueller, 2017). The use of technology-based EMA overcomes the shortcomings of paper-diaries by eliminating the need for manual data entry and increasing compliance (García-Palacios et al., 2014).

The application of EMA to the study of ER is boosting our knowledge about this process outside traditional experimental settings (Bylsma & Rottenberg, 2011), and a more complex representation of how people regulate their emotions and of the consequences of ER in daily life is emerging.

2.1. ER as a situated process

So far, most of the literature has relied on questionnaires that consider ER deployment as a stable trait. Yet, these trait measures only modestly correlate with ER implementation in daily life (Brockman, Ciarrochi, Parker, & Kashdan, 2017), which suggests that ER is a situated process. More specifically, dynamic variables like environmental factors, momentary affect and situation-specific goals should be considered together with more stable individual differences when understanding ER implementation in real life (**Figure 1**).

In relation to *environmental factors*, an increasing body of studies has explored the implementation of ER across different situations and results suggest that the frequency of use of such strategies might vary across environments. People would, for instance, increase reappraisal use in situations that are perceived as less controllable (Heiy & Cheavens, 2014). Interestingly, the influence of environmental factors on ER also includes the social context. For example, aa study indicated that suppression is more frequently adopted when other people are present in the environment, especially non-close partners (English, Lee, John, & Gross, 2017). Interestingly, studies using EMA have shown that also ER effectiveness is likely to be influenced by environmental factors. For example, positive rumination appears to have a greater impact on positive affect (PA) on days when less positive events occur (Li, Starr, & Hershenberg, 2017). Similarly, the negative impact of emotion suppression on PA is larger on more stressful days (Richardson, 2017), while state savoring would impact more on PA when few daily positive events occur (Jose, Lim, & Bryant, 2012).

Similarly, *momentary affect* is likely to shape the way people regulate their emotions (Brockman et al., 2017), especially when positive emotions are targeted (Brans, Koval, Verduyn, Lim, & Kuppens, 2013; Heiy & Cheavens, 2014). Emotional suppression and rumination would be fostered in the presence of momentary social anxiety (Farmer & Kashdan, 2012) and momentary negative affect (NA) (Li et al., 2017), while cognitive reappraisal and problem solving would be fostered by the experience of high levels of positive affective states (Brockman et al., 2017; Nezlek & Kuppens, 2008; Pavani, Le Vigouroux, Kop, Congard, & Dauvier, 2016).

Together with momentary affect and environmental factors, *situation-specific personal goals* have also shown to influence ER implementation (Kalokerinos, Tamir, & Kuppens, 2017). To name one example, a study revealed that distraction and cognitive reappraisal are more frequently used when hedonic rather than instrumental goals are pursued (English et al., 2017).

Finally, there is also evidence to suggest that non-situational factors, such as *individual differences* (Gross & John, 2003) like personality (Weiting & Diener, 2009) and psychopathology characteristics (Pollock, McCabe, Southard, & Zeigler-Hill, 2016) should be taken into account when investigating ER deployment. Suppression use, for instance, negatively correlates with extraversion (Catterson, Eldesouky, & John, 2016). Differently, the presence of depressive symptoms is associated with a more frequent use of rumination and dampening across time (Li et al., 2017; Pavani et al., 2016).

Overall, what these studies suggest is that ER is a complex and dynamic process that can't be grasped without taking into consideration the context in which emotions are being regulated.

2.2. How can ER affect our life?

ER and the adoption of specific strategies to regulate emotions have direct consequences on different aspects of our life (Gross, 2002), including emotions, physiological responses, and behaviors.

An increasing body of research adopting EMA has shown that ER has a deep impact on subsequent *affect and emotional experiences*. For example, when negative emotions are being regulated, the adoption of positive refocusing and acceptance has shown to predict subsequent mood improvement, while self-blame and generalizing are likely to result in mood worsening. When dealing with positive emotions, instead, behavioral activation, future focus and reminiscing are significant predictors of higher levels of PA (Heiy & Cheavens, 2014). Despite some contrasting results (Brockman et al., 2017; Heiy & Cheavens, 2014), the use of suppression has been shown to be associated with subsequent lower levels of daily PA (Richardson, 2017), higher levels of NA (Brans et al., 2013; Brockman et al., 2017; Nezlek & Kuppens, 2008), reduced daily well-being (Catterson et al., 2016), and decreased daily self-esteem and psychological adjustment (Nezlek & Kuppens, 2008). Differently, the use of cognitive reappraisal and mindfulness in daily life predicts subsequent higher levels of PA and lower levels of NA (Brockman et al., 2017; Heiy & Cheavens, 2014; Nezlek & Kuppens, 2008; Pavani et al., 2016; Richardson, 2017), regardless of daily stress levels (Richardson, 2017). Increases in daily self-esteem and momentary well-being have also been reported with the former ER strategy (Nezlek & Kuppens, 2008) and high levels of state mindfulness predict higher levels

of daily autonomy (Brown & Ryan, 2003). Rumination, instead, has a negative impact on daily NA (Pavani et al., 2016), and would also be a moderator in the association between daily unpleasant events and NA (Genet & Siemer, 2012).

The implementation of EMA has evidenced that ER deployment also has *physiological consequences* on our body. So far, rumination and its physiological effects have been largely investigated (Ottaviani et al., 2016) and there is increasing evidence suggesting that high levels of daily negative perseverative thinking are associated with increased cortisol levels, heightened activation of the hypothalamic–pituitary–adrenal axis (HPAA) and decreased heart rate variability (HRV) during waking, which at turn would affect sleep patterns.

Finally, a less explored area by EMA studies is represented by the consequences of ER on daily *behaviors*. There is evidence to suggest, however, that a relationship between ER and subsequent behavior can be effectively grasped using EMA. For instance, one study suggests that suppression of positive emotions leads to higher engagement in positive social events on the following days, while cognitive reappraisal deployment would be associated with the participation in less negative social events (Farmer & Kashdan, 2012). Weiss et al. (2017) also found evidence to suggest that momentary ER is associated with subsequent behavior. Specifically, the authors revealed that the implementation of distraction, cognitive reappraisal and problem solving but not of avoidance predicts a reduction in marijuana consume on the following evening among college students (Weiss, Bold, Sullivan, Armeli, & Tennen, 2017). Similarly, adolescents adopting disengagement (e.g., denial, avoidance, wishful thinking, escape, inaction) and involuntary engagement strategies (e.g., rumination, impulsive or involuntary action) have been found to report more subsequent problematic behaviors in daily life (Silk, Steinberg, & Morris, 2003).

3. Conclusions

As shown by a growing body of research adopting EMA for the investigation of emotional processes, ER is intrinsically connected to the context in which emotions are being regulated. Accordingly, the adoption of this approach could significantly deepen our understanding of ER and overcome the barriers of traditional laboratory and cross-sectional research. New theoretical models conceptualizing ER as a complex, heterogeneous and situated-process are needed. To do so, contextual and momentary aspects should be central elements in future ER research, so that between- and within-subject variations in ER daily dynamics can be dilucidated.

So far, EMA studies revealed that situational variables (e.g., environmental variables, momentary affect, and situation-specific goals) are likely to shape ER. Importantly, the impact might affect several aspects of ER, including strategy selection and frequency, and ER efficacy. These factors, that have been often understudied in ER research, are of fundamental importance in order to grasp the real nature of ER in real-life. In addition, EMA has also been shown to be an adequate tool for the investigation of ER momentary consequences. As noted previously, there is growing evidence to suggest that ER can affect several aspects of the individual, including emotions, physiological responses, and behaviors. By means of EMA, it is feasible to explore those by repeatedly assessing people in real-life settings, which can help to establish a causal rather than

correlational association between ER strategies and outcomes. Even though emotional and affective consequences have been widely studied through EMA, less efforts have been made to comprehend the relationship between ER and physiological responses. Furthermore, still little is known about how ER may affect subsequent maladaptive (such as conduct problems, suicide ideations, drugs abuse or abnormal sexual conducts) and adaptive behaviors (including academic or job performance, physical activity or social interactions) in daily life.

To date, most of the EMA literature has been based on the collection of self-reports by means of mobile devices, especially smartphones. Nevertheless, standardized and ad-hoc items to assess ER through EMA are currently not available, making it difficult to compare results across studies. Promisingly, state rather than trait ER questionnaires have recently started to be developed (Ganor, Mor, & Huppert, 2018; Marchetti, Mor, Chiorri, & Koster, 2018), that could easily be integrated into EMA designs. Moreover, further advances could be made by including more objective, passive data collection, such as data supplied by embedded sensors or wearable biosensors. By doing this, a more comprehensive understanding of ER deployment in daily life could be achieved, concurrently capturing different components of this process. Behavioral information can be enhanced through smartphones embedded-sensors, where for example sleep patterns, physical activity, social interactions or social media use can be monitored continuously, while wrist-watch or wearable chest-straps can easily obtain the physiological aspects contributing to the consequences of ER use in daily life. If integrated with traditional self-reports collected through EMA, not only can this information shed new light into the impact of ER deployment on daily behaviors and physiological responses, but also it could reduce the efforts required to regularly complete daily assessments.

Beyond these theoretical considerations, clinical implications are also worth mentioning. Even though we mainly considered ER consequences in healthy populations, EMA could also change the way we investigate ER in psychopathology by helping us understanding the direct consequences that emotion dysregulation has on patients' life (see for example Anestis et al., 2010; Czyz, King, & Nahum-Shani, 2018). This could help clinicians recognize specific ER strategies to be targeted in the therapeutic process, but it could also be used to provide therapeutic feedback to patients, which has been shown to be a valuable therapeutic procedure (Delgadillo et al., 2018). Yet, another example of how EMA could be used in clinical settings relies in the application of machine learning techniques. Behavioral models can be generated to represent for populations, where for example phenotyping or personalized models can be crafted to account for sub-population or individual differences. Such models can be made adaptive to gradual changes in lifestyle and behavior, while still being able to detect drastic changes. This would be extremely valuable in the context of monitoring and preventive healthcare. Sudden changes in emotional states are also easily identifiable in physiological data. Albeit not being able to reliably detect discrete emotions from physiological data, the combination of both can be complementary to one another, as there is information which cannot be captured by self-reports alone. Monitoring patients over time can yield indicators that are predictive of, for example, relapse. As such, further research utilizing both methods would ideally generate a larger corpus of data featuring both modalities. This can be used to apply data-driven approaches such as machine learning or predictive

modelling to estimate a person's future emotional state and ultimately to help us understand better the interplay between emotions, physiology and behavior. The utilization of data from different modalities will allow for a more in-depth modelling, detecting salient features and predictors applicable for mood dysregulation disorders.

To sum, EMA is a promising tool that is changing our conceptualization of ER into a more complex, contextually-influenced psychological construct. Several milestones have been already achieved in the literature using EMA for the study of ER, including the importance of context in ER implementation and the relationship between momentary ER and subsequent outcomes. While these results are promising, there are still some challenges that need to be addressed, such as the inclusion of more studies on the consequences of ER on subsequent physiological and behavioral responses, the use of devices that passively-monitor outcomes, and the generalization of ecological and momentary evaluation in clinical settings and routine care, where retrospective self-reports are still the norm.

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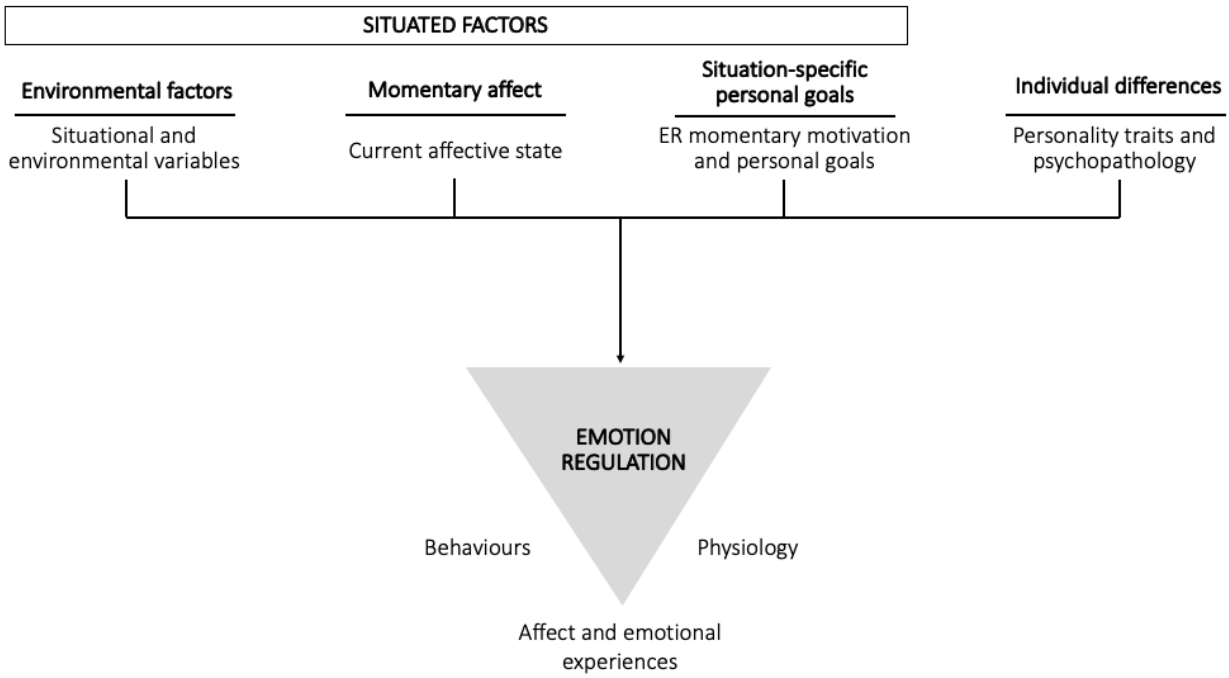

Figure 1: **Emotion regulation as a situated process**. Situated factors (i.e. environmental factors, momentary affect, situation-specific personal goals) and individual differences shape the way people regulate their emotions in everyday life. At turn, this regulatory process has direct consequences on daily behaviors, physiology, and affect and emotional experiences.

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