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The distinctive role of executive functions in implicit emotion regulation

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ABSTRACT

Several theoretical models stress the role of executive functions in emotion regulation (ER). However, most of the previous studies on ER employed explicit regulatory strategies that could have engaged executive functions, beyond regulatory processes per se. Recently, there has been renewed interest in implicit forms of ER, believed to be closer to daily-life requirements. While various studies have shown that implicit and explicit ER engage partially overlapping neurocognitive processes, the contribution of different executive functions in implicit ER has not been investigated. In the present study, we presented participants with negatively valenced pictures of varying emotional intensity preceded by short texts describing them as either fictional or real. This manipulation was meant to induce a spontaneous emotional down-regulation. We recorded electrodermal activity (EDA) and subjective reports of emotion arousal. Executive functions (updating, switching, and inhibition) were also assessed. No difference was found between the fictional and real condition on EDA. A diminished self-reported arousal was observed, however, when pictures were described as fictional for high- and mild-intensity material, but not for neutral material. The amount of down-regulation in the fictional condition was found to be predicted by interindividual variability in updating performances, but not by the other measures of executive functions, suggesting its implication even in implicit forms of ER. The relationship between down-regulation and updating was significant only for high-intensity material. We discuss the role of updating in relation to the consciousness of one's emotional state.

1. Introduction

Emotion regulation (ER) is the process of modifying the intensity, the duration or the type of a given emotional response in order to maintain an adaptive behaviour. ER can intervene at different moments of the emotion generative process. Accordingly, ER strategies have been classified as antecedent and response focused, corresponding to modulatory processes acting, respectively, before and after a full-fledged emotion response has emerged (Gross, 1998). The former encompasses attentional redeployment and reappraisal, while the latter is described as behavioural suppression (Gross, 2014). While they are commonly considered as respectively adaptive and maladaptive strategies, some studies showed that suppression abilities and emotional avoidance are, respectively, a positive predictor of distress adjustment (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004), and have a long-term adaptive value after real life grief (Bonanno, Keltner, Holen, & Horowitz, 1995).

Reappraisal has been described as an adaptive ER strategy (Aldao, Nolen-Hoeksema, & Schweizer, 2010), and has therefore undergone extensive research compared to other strategies. Previously considered as a unitary construct, recent studies have underlined its complexity. It is now conceptualized as a global term encompassing several mechanisms (Webb, Miles, & Sheeran, 2012). Positive reappraisal seeks to focus on or create a positive aspect or meaning for a stimulus. Detached reappraisal, or "detachment", differs conceptually as it strives to lower the self-relevance of the emotional event, disrupting the relationship between the event and the self, by acting for example, as if one was not personally concerned by the event or the stimulus, but merely a neutral observer.

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Distancing, on the other hand, requires a change in perspective, usually from the first- to the third-person perspective (e.g., to see yourself as a fly on the wall; Kross & Ayduk, 2011; Mischkowski, Kross, & Bushman, 2012). Finally, what could be called fictional reappraisal aims to lower the "realness" of a stimulus by reinterpreting its nature, or by giving it a fictional context (e.g., "it's not blood but ketchup"; Mocaiber et al., 2010; Mocaiber et al., 2011). While most studies asked participants to exert an "unspecified" cognitive reappraisal (although some studies did try tracking the strategies used afterwards; Moser, Most, & Simons, 2010), recent protocols tend to prompt participants to perform a specific subtype, or a combination of subtypes (e.g., detachment and distancing; Koenigsberg et al., 2009; Ochsner et al., 2004). Indeed, Dörfel et al. (2014) suggested that detachment is supported by different neural pathways from those supporting reinterpretation-based strategies, such as fictional reappraisal (note, however, that as the instructions were to "reinterpret the picture so that it no longer elicits a negative response" p. 300, they did not allow for a clear delineation and could also have included features of positive reappraisal). The authors emphasized that only the interpretation-based strategy activated the orbitofrontal cortex and the left ventrolateral prefrontal cortex. They pointed out the role of the anterior part of the latter structure in retrieving conceptual representations from memory and the middle part in selecting the right representation (and inhibiting the others), stressing the complex role of cognitive control in this type of emotion regulation.

In general, neuroimaging studies of ER have consistently reported activation in lateral and medial frontal regions encompassing the dorsal and ventral prefrontal cortex and the anterior cingulate cortex (for a meta-analysis of instructed emotion regulation protocols see Buhle et al., 2014). Interestingly, this fronto-cingular network is involved in domain general cognitive control (Niendam et al., 2012). These findings are in agreement with theoretical models invoking a central role of cognitive control processes in emotion regulation (Bush, Luu, & Posner, 2000; Makowski, Sperduti, Blanchet, Nicolas, & Piolino, 2015; Ochsner, Silvers, & Buhle, 2012; Ochsner & Gross, 2005).

Nevertheless, as proposed by Miyake et al. (2000), cognitive control is not a unitary phenomenon, but encompasses at least three different executive processes: switching, updating, and inhibition. Switching corresponds to the ability to flexibly switch between different tasks at hand, updating to the monitoring and continuous manipulation and refreshing of working memory content, and inhibition to the voluntary suppression of prepotent or habitual responses. Only a few studies have investigated the contribution of specific executive functions (EF) to ER efficiency. Schmeichel, Volokhov, and Demaree (2008) showed that participants with higher working memory scores (operation span task) were better able to use suppression and reappraisal to reduce their expressive and subjective emotional reactions. In the same vein, Opitz, Lee, Gross, and Urry (2014) reported that fluid cognitive intelligence (comprising a working memory measure) predicted the efficacy of using reappraisal to modulate emotional response.

Studies employing multiple measures of EF have reported contrasting results. For example, McRae, Jacobs, Ray, John, and Gross (2012), in line with the aforementioned studies, showed that working memory (operation span task) and switching (global/local task), but not inhibition abilities, positively correlated with reappraisal efficiency. On the contrary, in two studies, Gyurak et al. (2009) and Gyurak, Goodkind, Kramer, Miller, and Levenson (2012) reported that only verbal fluency, but not inhibition, working memory (composite score of digit and spatial span) or task switching (TMT), was linked to higher abilities to regulate emotion using suppression. These findings suggest that different EF could be engaged depending on the ER strategy at stake. Working memory could be necessary during reappraisal since the alternative interpretation of the stimuli should likely be held in memory to be effective in modulating the emotional response. Moreover, it should be noted that previous studies employed different working memory measures, reporting that more complex working memory tasks (operation span task) requiring storing and active manipulation were related to ER abilities (Schmeichel & Demaree, 2010; Schmeichel et al., 2008), while performances in simple working memory tasks (digit span) were not (Gyurak et al., 2009, 2012). These findings suggest that complex executive functions could be better predictors of regulatory abilities. Nevertheless, no previous study employed different measures of the same cognitive ability (e.g., working memory) to directly test this hypothesis.

The majority of studies explicitly asked participants to engage in one of the aforementioned ER strategies to modulate their emotional experience. The voluntary deployment of ER could require the mobilization of cognitive resources and be intrinsically effortful (for a recent review see Gyurak, Gross, and Etkin, 2011). It is therefore not clear if the activation of brain structures subserving cognitive control during ER, and the link between executive functions and ER abilities, are due to ER per se, or are linked to the voluntary and effortful nature of these tasks.

Beyond voluntary ER, different forms of implicit ER have been described. These processes differ from explicit forms of ER in that regulation occurs without explicit instructions to modulate the emotional response and the regulatory process remains outside the participants' awareness (Gyurak et al., 2011). For example, several studies have shown that asking participants to verbally label the emotional expression of faces or their emotional reaction elicited by arousing pictures produced an incidental emotional modulation witnessed by diminished emotional subjective rating and decreased activity in brain regions devoted to processing emotion (Burklund, David Creswell, Irwin, & Lieberman, 2014; Lieberman et al., 2007). Interestingly, these studies also showed that implicit ER activated the same frontal regions recruited during reappraisal, suggesting that explicit and implicit ER processes could be subserved by partially overlapping mechanisms.

Contextual cues have also been shown to incidentally modulate emotional response. For example, verbal descriptions presented prior to showing negative pictures and describing the stimuli as more neutral or more negative have been shown to modulate the neural signature and the subjective rating of emotion (Foti & Hajcak, 2008; Macnamara, Foti, & Hajcak, 2009). In particular negative images preceded by a neutral description elicited a reduced late positive potential (LPP) and were judged as less unpleasant.

Other studies showed that describing emotional material as fictional (by means of short texts) could trigger implicit emotion regulation processes (Mocaiber et al., 2011; Mocaiber et al., 2010; Sperduti et al., 2016). Mocaiber et al. (2010) showed that mutilation pictures that were presented as fictional (movie scenes) elicited a smaller LPP compared to similar pictures presented as real. In a further neuroimaging study, using the same manipulation, the authors reported the activation of brain regions associated with emotional processing – amygdala and insula – in the real, but not in the fictional condition (Mocaiber et al., 2011), while the fictional condition triggered activity in prefrontal regions. Oliveira et al. (2009), using a similar protocol, showed an effect of a personality trait (positive affect, measured by the PANAS-T; Watson, Clark, & Tellegen, 1988) on emotion regulation abilities. Only the high positive affect subgroup showed a reduction in physiological arousal, measured by means of electrodermal activity (EDA) and heart-rate deceleration, toward pictures described as fictional. The authors suggested that since positive affect increases cognitive flexibility (Dreisbach, 2006), individuals with high positive affect could be more efficient in modulating their emotion response. In a more recent study, we showed, using more ecologically valid material (movie clips), compared to previous studies employing pictures (Mocaiber et al., 2010, 2011; Oliveira et al., 2009), that scenes presented as fictional were judged as less arousing (Sperduti et al., 2016). Moreover, we reported that modulation of subjective emotion by fictional description was evident for negative, but not for positive scenes. It has to be noted, however, that negative scenes were also judged more arousing than positive ones. Thus, it is not clear if this difference was driven by valence or intensity.