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## RESEARCH ARTICLE

# Modeling the effect of regulation of negative emotions on mood



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### Abstract

In this paper a computational model is presented that describes the role of emotion regulation to reduce the influences of negative events on mood. Emotion regulation is a process based on a set of regulatory strategies used by persons to down-regulate their negative emotions or to up-regulate their positive emotions. For a given situation, the selection of specific regulation strategies is dependent on that particular situation. The current paper presents work focusing on a cognitive reappraisal (re-interpretation) strategy, that involves changing the way one interprets a stimulus or situation, or alter the semantic representation of an emotional stimulus in order to reduce the influence of such stimuli. The model incorporates an earlier model of mood dynamics and a model for the dynamics of emotion generation and regulation. Example model simulations are described that illustrate how adequately emotion regulation skills can avoid or delay development of a depression. The presented computational analysis shows how regulation of stressful emotions helps unstable persons to avoid a depression, and to postpone it in very unstable persons. Furthermore, the analysis shows that if a stressful event persists for a longer time period, then emotion regulation can also help an unstable person to prevent the mood level from becoming too low, for a certain time.

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## Introduction

Emotions were traditionally seen as neural activation states without function (Hebb, 2002). However, relevant research provides evidence that emotions are functional (Damasio, 2000; Oatley & Johnson-laird, 1987) and provide

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information about the ongoing mutual interaction between a human being and his or her environment (Schwarz & Clore, 1983). Moreover, emotions have a strong impact on the way we interact with the social world (Gross, 2015). In addition to the theories that exist in social psychology, in recent neurological literature many contributions (e.g., Damasio, 2000; Schwarz & Clore, 1983) can be found about the relation between emotion and brain functioning. For example, emotional responses relate to activations in the brain within the limbic centers (generating emotions), and cortical centers (regulating emotions); e.g., Dalglish (2004) and Papez (1937). Previously, emotions were often left out of cognitive models; however, since awareness is increasing that emotions play a vital role in human life, nowadays cognitive models are developed that include the generation and regulation of emotions as well. A useful basic theory for the latter is Gross theory about how individuals regulate the emotions they have, when they have them and how they experience and express them (Gross, 1998).

Emotions are different from mood, and emotion regulation is different from mood regulation (Gross, 1998; Gross, 2001). Emotions are instantaneous in nature and are specific reactions to a particular event, usually for a short period of time. Emotions help us to set priorities in our lives, taking initiatives in changing situations or making decisions based on how we feel, whether we are happy, angry, frustrated, bored or sad. In psychology, emotion regulation is considered as an important aspect in the context of generation of human behavior (Gross, 2015). Recent literature shows that emotion regulation is gaining attention from a variety of biological and cognitive disciplines (Hartley & Phelps, 2010; Miller, Rodriguez, Kim, & McClure, 2014), as well as from social and health related areas (DeSteno, Gross, & Kubzansky, 2013; Shaver & Mikulincer, 2014). Emotion regulation describes how a subject can use specific strategies to affect the emotional response levels.

Mood, on the other hand, is a more general feeling such as happiness, sadness, frustration, or anxiety that exists for a longer period of time (Gross, 2015; Larsen, 2000). Mood regulation usually involves the deliberate choice of mood-affecting activities, such as pleasant activities (Cuijpers, van Straten, & Warmerdam, 2007). Moods tend to have less definite behavioral response tendencies than emotions; therefore, mood regulation may be distinguished from emotion regulation by its predominant focus on changing subjective feeling states (Larsen, 2000). It has been found that recurring events triggering stressful emotions have a bad influence over time on mood and can easily lead to depression when subjects are vulnerable to that (Kessler, 1997; Monroe & Harkness, 2005).

The current paper is based on an extension of material presented earlier in (Abro, Klein, Manzoor, Tabatabaei, & Treur, 2014). In this paper, a computational model is introduced that combines the short-term emotional reaction on stressful events with the long-term dynamics of mood. The model is based (1) on an existing model for mood dynamics (Both, Hoogendoorn, Klein, & Treur, 2008; Both, Hoogendoorn, Klein, & Treur, 2015) and (2) on the theory of emotion regulation introduced by (Gross, 1998; Gross, 2001; Gross, 2002). Various simulation experiments have been performed to analyse how the process of emotion

regulation can help persons maintain a healthy mood in case of the occurrence of stressful events that recur from time to time or even continuously.

The paper is organized as follows. First, some background information about the mood model and the process of emotion regulation presented. Then, the integrated model is explained in detail. In Section 'Simulation Results' simulation results are provided to show the influence of stressful events in different scenarios, thereby providing evidence for the feasibility of the model. The next section is a discussion. Finally, the last section concludes the paper.

## Background on emotion regulation and mood dynamics

The model presented in this paper adopts Gross' theory of emotion regulation and an existing model of mood dynamics (Both et al., 2008; Both et al., 2015). Both elements are introduced here briefly.

### Emotion regulation

Controlling emotions or regulating them is often related to the suppression of an emotional response, for example, expressing a neutral poker face. This kind of regulating emotions is sometimes considered not very healthy, and as a risk for developing serious kinds of health problems. However, it has been found that the strategies to regulate emotions are much more varied. For example, closing or covering your eyes when a movie is too scary, or avoiding an aggressive person are other forms of emotion regulation mechanisms (Goldin, McRae, Ramel, & Gross, 2008; Gross, 2002). In daily life, decreasing negative emotions seems as the most common form of emotion regulation. Also in the literature, emotion regulation is often described as the process to down-regulate negative emotions, and particularly much attention has been paid towards reduction of the experiential and behavioral aspects of sadness, anger and anxiety (Richards & Gross, 2006). On other hand, there has also been a particular focus on the feelings of love, interest, and joy to up-regulate positive emotions (Quoidbach, Berry, Hansenne, & Mikolajczak, 2010).

In recent literature on emotion regulation, another distinction has been made by Gross (2014). Emotion regulation is further classified according to two broad categories. The first one is called internal emotion regulation (intrinsic emotion regulation): when such people who have the objective to regulate their own emotions. The other category is named external emotion regulation (extrinsic emotion regulation): when a person has the objective to regulate another person's emotions (Bloch, Haase, & Levenson, 2014; Levenson, Haase, Bloch, Holley, & Seider, 2014; Zaki & Williams, 2013). The current paper focuses on the first category.

The framework originally introduced by Gross describes how emotions can be regulated or controlled in different phases of the process when emotions are generated (Gross, 1998). Gross distinguishes cognitive regulation of emotions, which occurs relatively early in the emotion generation process (e.g., re-interpretation) and behavioral

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