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Regulating emotions uniquely modifies reaction time, rate of force production, and accuracy of a goal-directed motor action

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ABSTRACT

We investigated how emotion regulation (ER) strategies influence the execution of a memory guided, ballistic pinch grip. Participants ($N = 33$) employed ER strategies (expressive suppression, emotional expression, and attentional deployment) while viewing emotional stimuli (IAPS images). Upon stimulus offset, participants produced a targeted pinch force aimed at 10% of their maximum voluntary contraction. Performance measures included reaction time (RT), rate of force production, and performance accuracy. As hypothesized, attentional deployment resulted in the slowest RT, largest rate of force production, and poorest performance accuracy. In contrast, expressive suppression reduced the rate of force production and increased performance accuracy relative to emotional expression and attentional deployment. Findings provide evidence that emotion regulation strategies uniquely influence human movement. Future work should further delineate the interacting role that emotion regulation strategies have in modulating both affective experience and motor performance.

1. Introduction

From the rather mundane events of daily commutes (Pêcher, Lemercier, & Cellier, 2009), social interactions (van Kleef, 2009), and performance of occupational duties (Tsai, Chen, & Liu, 2007),

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to challenging tasks associated with executing skilled medical surgery (Arora et al., 2010), engaging in military maneuvers (Wallenius, 2004), and competing in sport (Causer, Holmes, Smith, & Williams, 2011), emotional states pervasively influence human behavior. A growing database indicates that emotions directly impact how people move by modulating the speed of reactions (Chen & Bargh, 1999; Rotteveel & Phaf, 2004), rate of movement (Gross, Crane, & Fredrickson, 2012), accuracy of movements (Coombes, Janelle, & Duley, 2005), and magnitude of force production (Coombes, Cauraugh, & Janelle, 2006; Coombes, Gamble, Cauraugh, & Janelle, 2008). However, people do not always experience emotions passively. Rather, in the interest of attaining affective, cognitive, and behavioral goals, they implicitly or explicitly apply regulatory strategies that modify emotional experiences and physiological reactivity (Gross, 1998; Jackson, Malmstadt, Larson, & Davidson, 2000; Kanske, Heissler, Schönfelder, Bongers, & Wessa, 2011; McRae et al., 2009; Webb, Miles, & Sheeran, 2012). Understanding how emotion regulation strategies influence motor execution is therefore fundamental to the development of empirically founded guidelines for implementing effective regulation strategies in myriad performance environments. Yet, how the deliberate regulation of emotion modulates the influence of emotional experience on human motor action remains unspecified.

In the present study, we evaluated how three established emotion regulation (ER) strategies influenced motor action under varying emotional conditions. Participants executed a memory guided, ballistic pinch grip while either passively experiencing emotional stimuli, or regulating emotional experiences via expressive suppression, emotional expression, or attentional deployment. *Expressive suppression* involved minimizing the external expressions of emotional experience. For example, participants were instructed to mask their expressions so that if someone were watching, they would not be aware of what the participants were feeling. In contrast, participants were instructed to fully express their emotional reactions during *emotional expression*. When employing *attentional deployment*, participants completed a backward counting task in which gaze was maintained on the screen, but attention was diverted to the counting task and away from emotional content. Reaction time (RT), peak rate of force production (PRF), and root-mean-square error (RMSE) were used to quantify how the execution of speeded motor actions varies as a function of induced emotional states and the strategies employed to regulate the experienced emotions.

Intuitively, effective regulation of emotional experience may seem beneficial to performance within emotionally charged environments. Supporting this notion, emerging evidence (Bresin, Fetterman, & Robinson, 2012) suggests that individual differences in adaptive ER tendencies predicts improved motor control accuracy. Additionally, work from several lines of research highlight common neurological networks activated during the experience of emotion, regulation of emotional experience, planning of action, and execution of motor responses (Coombes, Corcos, Pavuluri, & Vaillancourt, 2012; Heimer & Van Hoesen, 2006; Hikosaka, Sesack, Lecourtier, & Shepard, 2008; Mauss, Bunge, & Gross, 2007; Mogenson, Jones, & Yim, 1980). In addition to the affective benefits of managing emotional experience (e.g., Webb et al., 2012), actively regulating emotions during motor tasks should concurrently regulate the influence of emotional states on downstream motor actions. In accordance with previous evidence that emotional states speed RTs (e.g., Coombes, Higgins, Gamble, Cauraugh, & Janelle, 2009), we predicted that emotional states would speed RT on trials that followed unregulated viewing of emotional stimuli. A replication of this emotion-modulated RT effect would allow us to then determine whether ER strategies impacted ensuing motor actions. We expected emotional-state dependent RT differences to disappear when participants employed regulation strategies.

Although the active regulation of emotion may buffer the influence of emotional experiences on motor action, such regulatory benefits may potentially manifest at a cost to efficiency and efficacy of motor execution. Effective execution of goal directed, ballistic motor actions is primarily reliant on the integrity of top down executive processes that direct the initiation and control of movement (Coombes, Cauraugh, & Janelle, 2007a,b; Glover, 2004). ER strategies are known to activate pre-frontal regions associated with attention, cognition, and motor control (Coombes et al., 2012; Goldin, McRae, Ramel, & Gross, 2008; Kanske et al., 2011; McRae et al., 2009). Provided that dual-task paradigms impair motor performance—presumably due to competition for brain regions involved in both tasks—(Rémy, Wenderoth, Lipkens, & Swinnen, 2010), the implementation of regulation strategies that place