A COMPARISON OF EMOTION REGULATION STRATEGIES’ EFFECTIVENESS UNDER COGNITIVE FATIGUE

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การเปรียบเทียบประสิทธิผลของวิธีการกำกับอารมณ์ในสภาวะเหนื่อยล้าทางความคิด

น.ส.ศิรินภา ชูรัศมี

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรมหาบัณฑิต
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ศิรินภา ชูรัศมี : การเปรียบเทียบประสิทธิผลของวิธีการกำกับอารมณ์ในสภาวะเหนื่อยล้าทางความคิด. (A COMPARISON OF EMOTION REGULATION STRATEGIES' EFFECTIVENESS UNDER COGNITIVE FATIGUE) อ.ที่ปรึกษาหลัก : อ. ดร.กฤษณ์ อริยะพุทธิพงศ์

งานวิจัยนี้เปรียบเทียบประสิทธิผลของวิธีการกำกับอารมณ์ 3 วิธีภายใต้สภาวะเหนื่อยล้าทางความคิด คือ วิธีการเปลี่ยนความคิด วิธีการเบี่ยงเบนความสนใจ และ วิธีการเรียกชื่อความรู้สึก โดยเงื่อนไขในการทดลองประกอบไปด้วย 2 (มีความเหนื่อยล้าทางความคิดและไม่มีความเหนื่อยล้าทางความคิด) x 3 (วิธีการกำกับอารมณ์ 3 วิธี) แบบวัดซ้ำภายในบุคคล (within-subject) ผู้เข้าร่วมการทดลอง 46 คน ถูกสุ่มเข้าเงื่อนไขโดยรูปแบบการเข้าเงื่อนไขอย่างไม่สมบูรณ์ (incomplete block design) งานวิจัยนี้ใช้คะแนนการรายงานความรู้สึกทางลบด้วยตนเอง (self-report negative emotions) และการวัดการต้านทานทางผิวหนัง (skin conductance) ต่อภาพกระตุ้นอารมณ์เพื่อเปรียบเทียบประสิทธิผลของวิธีการกำกับอารมณ์ ผลการทดลองพบว่า วิธีการเปลี่ยนความคิดมีประสิทธิผลในการลดอารมณ์ทางลบมากที่สุดเมื่อเปรียบเทียบกับวิธีการเบี่ยงเบนความสนใจและวิธีการเรียกชื่อความรู้สึกตามลำดับ ทั้งในเงื่อนไขมีความเหนื่อยล้าทางความคิดและไม่มีความเหนื่อยล้าทางความคิด ในขณะที่วิธีการเปลี่ยนความคิดมีประสิทธิผลที่ดี วิธีการกำกับอารมณ์ที่ใช้ทรัพยากรทางความคิดน้อยกว่าอีกสองวิธีก็มีผลที่ดีเช่นกัน งานวิจัยนี้มีความสอดคล้องกับการวิจัยก่อนหน้าที่เสนอว่าวิธีการเปลี่ยนความคิดมีประสิทธิผลที่ดีกว่าวิธีการเบี่ยงเบนความสนใจและวิธีการเรียกชื่อความรู้สึก อย่างไรก็ตาม งานวิจัยนี้ไม่พบผลความแตกต่างของการตอบสนองทางอารมณ์ในเงื่อนไขมีความเหนื่อยล้าทางความคิด

สาขาวิชา	จิตวิทยา	ลายมือชื่อนิสิต	
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Sirinapa Churassamee : A COMPARISON OF EMOTION REGULATION STRATEGIES’ EFFECTIVENESS UNDER COGNITIVE FATIGUE. Advisor: KRIS ARIYABUDDHIPHONGS, Ph.D.

This research compared the effectiveness of three emotion regulation strategies including reappraisal, distraction, and affect labeling under cognitive fatigue. In the 2 (fatigue vs. non-fatigue) × 3 (emotion regulation strategies) within-subject design, 46 participants were randomly assigned into conditions using an incomplete block design method. Self-report negative emotions and skin conductance responses to emotion-eliciting pictures were measured to compare the effectiveness of the strategies. Results showed that reappraisal was more effective in regulating negative emotions than distraction and affect labeling in both fatigue and non-fatigue conditions. While reappraisal was a robust method of regulating emotion, the other two less-demanding strategies show some promising results. The present study provided a consistent conclusion with previous works which showed that reappraisal worked better than distraction and affect labeling. However, no difference in emotional responses was found when comparing the cognitive fatigue conditions.

Field of Study: Psychology
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Student's Signature ....
Advisor's Signature ....

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Sirinapa Churassamee

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Introduction

“We suffer more in imagination than in reality.”

—— *Seneca (4 BCE - 65 CE)*

Emotions are basic human experiences that play important roles in our daily basis (Frijda, 1986; Lazarus, 1991a). For example, some emotions such as fear or anger guide us on how to respond to threats while some other emotions such as happiness and joy help us with our personal growth and interpersonal relationship goals. For some other times, anger makes us lose control of our behaviors. The impact of emotion underscores the crucial role of emotion regulation in human’s life.

Emotion regulation refers to the process of cognitively controlling our emotions, the attention we give to emotions, and the way we interpret and experience emotions (Gross & John, 2003). It is widely regarded that individuals deal with negative emotions differently (Gross, 1998; Koole & Rothermund, 2011). For instance, one could opt to reinterpret the emotional situation while others might prefer to entirely ignore it. Different approaches to emotion regulation may lead to various outcomes depending on one’s situation. One of the common approaches called cognitive reappraisal was proposed by Gross (1998). The approach involves how an individual changes his or her mindset towards a certain situation in order to alter an emotional impact. Numerous studies found that there was an association between cognitive reappraisal and one's well-being, as well as a personal relationship (i.e., Gross, 1998; Gross & John, 2003; Gross & Thompson, 2007) However, previous studies suggest that reappraisal usually requires effort and drains cognitive resources because an individual has to be fully aware of their emotional experiences and reinterpret the situations. Individuals may find it hard to manage their emotions using reappraisal method when their mind is tired (Grillon et al., 2015). While cognitive reappraisal was shown to be an effective method, it is not the sole strategy for emotion regulation. In this research, two additional emotion regulation strategies, i.e., distraction and affect labeling are selected to be investigated. Distraction refers to a way in which individuals try to deploy attention away from the emotion-eliciting events or stimuli (Thiruchselvam et al., 2011). Research has shown that distraction is a particularly effective strategy to inhibit emotional information before a full-blown emotion takes place (Lench et al., 2016; Sheppes & Meiran, 2007). Moreover, it can be implemented before or after exposure to emotional events (Gross & Thompson, 2007). The other strategy, affect labeling, is an implicit form of emotion regulation, which refers to a way people name their feelings (e.g., I feel fear). This strategy may not even sound like a regulatory process, however, several studies have revealed that affect labeling can also reduce negative emotions similar to reappraisal and distraction (Hariri et al., 2002; Torre & Lieberman, 2018).

To the best of my knowledge, no study to date has directly compared the effectiveness of the three strategies mentioned earlier. In addition, little of previous research has directly investigated the impact of cognitive fatigue on the effectiveness of various emotion regulation strategies (Grillon et al., 2015; Schmeichel, 2007). Previous research only suggested that the three strategies work at a different stage of cognitive processing (Opitz et al., 2014; Ortner et al., 2013; Schmeichel, 2008), have distinctive cognitive demand (Strauss et al., 2016), and require a different time of implementation to be more effective (Sheppes & Meiran, 2007).

Thus, the main objective of this research was to directly examine the effectiveness of emotion regulation strategies including cognitive reappraisal, distraction, and affect labeling under cognitive fatigue. This study was designed to address this question based on an experimental method that included measuring negative emotions by physiological responses i.e., skin conductance. Skin conductance is a reliable measure of aversive states which provides data that can be obtained quantitatively (Boucsein et al., 2012).

Emotion and Emotion Generation

Emotions may automatically arise from an instinctive state of one's mind when a person is experiencing a critical event, such as a time when the person gets horrified by a snake (Ledoux, 1995). For some other time, emotions may arise after consideration and may require some analysis. For example, when a romantic relationship ends, sadness may be elicited by an appraisal that something cannot be recovered (Smith & Lazarus, 1993). Emotions in this present work refer to people's valenced reactions to events that they perceive as relevant to their ongoing concerns (Gross, 1998). Despite different theories of emotions proposed over the years, there seems to be a common understanding that emotional states are characterized by subjective experiential, physiological, and behavioral responses to clearly identifiable stimuli. (Frijda, 1986; Mauss et al., 2005; Ochsner & Gross, 2005). According to Sander et al. (2005), emotions are short-lived and connected to a specific event, either internal (e.g. individual's own behaviors or thoughts) or external ones (e.g. individual's surroundings: sound, temperature, light).

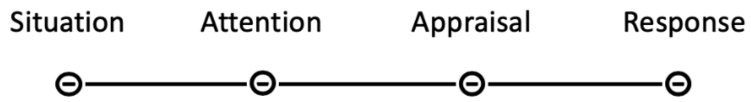
Many emotion theorists have tried to explain how emotions are generated. Physiological theories proposed that emotions occur as a result of physiological reactions to the events. For instance, James-Lange Theory of Emotion (Lang, 1994) suggests that emotions are results of physiological responses, which means physiological reactions always occur before emotions, not the other way around. Cannon (1927) also proposed Canon-Bard Theory of Emotion suggesting that events and stimuli are evaluated for individual's needs and goals, which means that physiological reactions to different emotions can be extremely similar. For example, one could see a snake and experience intense physiological reactions (i.e., heart rate and blood pressure rise) and psychological experience (i.e., fear) at the same time, and these experiences do not cause the other.

These views of physiological theories emphasize the intensity of emotions which are accompanied by increased levels of physiological arousal which means ones could experience emotions with or without thinking/interpreting/contemplating about it. However, cognitive theories argued that thoughts and other mental activity play an essential role in generating emotions, for example, Cognitive Appraisal Theory (Lazarus, 1991a); Lazarus (1991b) suggests that individuals' private interpretations of an event define their emotional reactions before emotional experiences take place. For example, one could experience "anxiety" by thinking about how he would fail a job interview the next day, as a consequence, this interpretation causes his hands to sweat and his blood pressure to rise (physiological reaction).

In 2007, Gross and Thompson proposed 'The Modal Model of Emotion,' which suggests that emotions stem from a person-situation interaction. Emotions unfold over multi-componential sequence that involves four stages. First, emotions begin when an individual encounters an external (e.g., a person literally sees blood) or internal situation (e.g., a person visualizes blood scene). Second, the individual attends to emotional cues that, third, leads him or her to appraise an emotional stimulus. Finally, the individual's emotional response is expressed. This process model is consistent with Frijda (1986)'s and Lazarus (1991b)'s that arousal of emotion is viewed as a series of steps.

Figure 1

The Model Of Emotion Generation Based on The "Modal model" of Emotion (Gross, 1998)



Nevertheless, individuals may realize a flowing stream of emotions and, yet, fail to control their own reactions. Emotional responses influence how people react to challenges and situations they confront. Therefore, it is crucial to learn to regulate those responses when they mismatch to a particular situation in order to better maintain the wellness of ones' lives and serve one's' goals (Bargh & Williams, 2007; Koole, 2009).

Emotion Regulation

Emotion regulation primarily refers to the process of cognitively controlling our emotions, the attention we give to emotions and the way we interpret and experience emotions. Thompson (1994) refers to emotion regulation as a process, which involves changes in emotion dynamics or the latency, rise time, magnitude, duration, and offset of responses in behavioral, experimental, or physiological domains. Regarding Goleman's (1995) emotion regulation definition, it is a process where people themselves seek to control their immediate and flow of emotions.

Therefore, emotion regulations do not take place only when individuals try to decrease negative emotions, but also when individuals try to increase and maintain positive emotions. For Gross (1998), emotion regulation is the processes where one can impact one's own emotion by choosing which emotion one wants to have and how one wants to experience and express them.

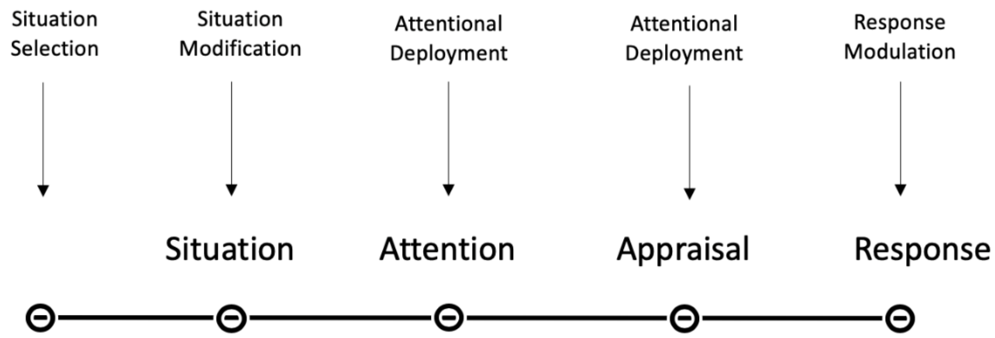
In daily life, people are frequently exposed to emotional provocations like internal feelings such as having a headache, and external events such as hearing music in a cafe that surreptitiously arouses their emotions. According to Davidson (1998), it can be inferred that people are prone to unknowingly experience emotion regulation almost all the time, providing that the mentioned stimuli do not always activate people's fully developed emotions. Furthermore, emotion regulations can occur outside conscious awareness (Cole et al., 1994), such as when an individual immediately turns away from something that upsets them. On the other hands, people may sometime be more overt in manifesting their emotion regulation. For instance, there are reliable observations that "people may rapidly shift their attention away from threatening stimuli" (Langens & Morth, 2003), that "people may overcome traumatic experiences by writing about them" (Pennebaker & Chung, 2007), and that "people may choose to hit a pillow instead of lashing out at the true cause of their anger" (Bushman et al., 2001). This can be said that from the aforementioned cases, people consciously oppose being carried away by their abrupt emotional impacts that may negatively affect the ongoing situations. Some other researchers, in turn, consider emotion regulation as being carried out by the external environment. For instance, environmental research by Van den Berg et al. (2007) has shown that people living with natural surroundings are likely to recover more rapidly from distress than the ones living with urban surroundings. In the case of small children, many times, it is the caregivers who help them regulate their emotions (Southam-Gerow & Kendall, 2002) Therefore, self-emotional regulation and outside the self-regulation are both important.

The Process Model of Emotion Regulation

The ‘Modal Model' of emotion provides a foundation for the main points in the emotion-generative process and the way in which an emotional response is formed and carried out. Building upon the modal model, (Gross, 1998) proposed the ‘Process Model’ of emotion regulation, suggesting that emotion regulation is a multi-componential process (see **Figure 2**). Gross’s emotional process distinguishes different control strategies by the time of occurrences: antecedent-focused or response-focused with respect to a given cycle through the emotion-generative process.

Figure 2

The Process Model of Emotion Regulation (Gross, 1998)



Antecedent-focused process refers to strategies or manipulations of an input to the emotion system before behaviors and response tendencies have been fully activated.

Situation selection involves how individuals avoid or attend the emotional situation. If a person chooses to escape the situation, therefore an individual may avoid the emotional impact that will occur. In contrast, if an individual chooses to attend the situation, they may involve emotion processes onward (Gross & John, 2003). Adaptive situation selection involves knowing oneself and one's needs, forecasting the emotions that countless situations are expected to produce. It is challenging for an individual to be effective at selecting the situation as they may fail to make decisions due to inaccurate forecasting.

Situation modification refers to ways in which individuals aim to modify the situation so they can amend their emotional impact. For example, individuals may attempt to fix problems by seeking out solutions before the situations get worse (problem-solving) or ask their peer for social supports (support-seeking). Although situation modification strategies make an early impact on the emotion generation process, it is impossible to modify every emotion-eliciting situation.

Attentional deployment refers to ways individuals who already attended the situation alter their feelings by selecting information to which they attend. It may include, for example, closing the eyes in front of unwanted scenes in the movie (physical withdrawal), internally shifting the attention to something else (distraction), trying to think about the situation as much as possible (rumination), or being mindful about what is happening (mindfulness).

Cognitive change refers to ways individual changes the way they think in order to change the way they feel. They may either change how to think about the situation itself (cognitive reappraisal) or about our ability to manage its impacts (self-efficacy appraisal). For instance, people may reinterpret a distressful situation as being harmless or assume the position of a detached observer (Ochsner & Gross, 2008).

On the other hand, the response-focused process refers to strategies that directly influence physiological, experiential, or behavioral responses. *Response modulation* is a family of strategies that aim to change experiences occurred after emotions have been established. Some individuals may try to suppress the feelings (expressive suppression; Butler et al., 2003; Moore et al., 2008), while others may use a more effective way by share emotions with significant others (emotional sharing; Brans et al., 2014).

Gross (1998)'s process model conceptualizes phenomena in term of simple, linear, and causal processes with the emotion or feeling unfolding from antecedents to consequences. The model also provides several major contributions to the understanding of emotion regulation, that is, the model provides a comprehensive descriptive framework for categorizing different emotion regulation strategies, as well as, explains why some emotion regulation strategies may be more effective than others. Precisely, the process model suggests that emotion regulation strategies are likely to be successful and less effortful when they are applied earlier rather than later.

Emotion regulation may also occur without conscious awareness, for example, one may distract himself from distress situation by turning his face away unconsciously. However, many examples of emotion regulation regarding Gross's model are conscious because from his perspective, emotion regulation is defined as goal-directed processes (Gross & Thompson, 2007). Later on, Gyurak et al. (2011) proposed A Dual-Process Framework that integrates explicit and implicit forms of emotion regulation. The model suggests that explicit emotion regulation can modify the direction of which people consciously want to feel that may seem more practical, however, implicit emotion regulation has the advantage of being more efficient and effortless than explicit regulation and individuals engage implicit emotion regulation on a regular basis, for example, one can explicitly remind oneself that a person who cut his car off the road might have a very rush day, and another time, he or she might reappraise this situation without any awareness. Therefore, unconscious and conscious regulation are not mutually exclusive. This suggests that people can practice specific explicit regulating strategies and turn them to habitual regulating methods.

Emotion Regulation strategies

As described previously, the goal of emotion regulation can be accomplished through different strategies. Various research has shown the effectiveness of multiple strategies, such as mindfulness, using humor, toward negative emotions. However, there are three strategies that will be emphasized in this literature.

Cognitive Reappraisal

Cognitive reappraisal is one of the most promising strategies in a response-focus process refers to ways in which individuals change how they think about a situation before emotions take place. Reappraisal requires reinterpretation of an emotionally evocative stimulus in order to alter its emotional impact (Gross, 1998; Gross & John, 2003; Gross & Thompson, 2007). The outcome of reappraisal is usually an increase in positive emotion and decreasing negative emotion. According to Gross' modal model of emotion, when an individual changes the way he or she thinks about the situation, the emotional responses change consequently. For example, when a person fails an exam, he or she may typically think that his or her life will become more difficult. As a result, the person experiences "fear" as an emotion. However, when the person changes the way he or she thinks about the event (i.e., reappraisal), for instance, by framing the failure as an opportunity to improve one’s self, the person may experience less fear or even feel different emotion such as "excitement".

Previous studies have shown that cognitive reappraisal had a positive effect on emotional outcomes. For example, Gross and John (2003) studied individual differences in two emotion regulation processes including cognitive reappraisal and expressive suppression and found that individuals who habitually use reappraisal experience and express greater positive emotion compared to those who habitually use suppression strategies. Moreover, Gross suggested that using reappraisal is associated with better interpersonal functioning, whereas using suppression is associated with worse interpersonal functioning. Besides, the study also showed that using reappraisal is related positively to well-being, whereas using suppression is related negatively. In the same vein, Mauss et al. (2007), studied individual differences in cognitive reappraisal in response to an anger provocation in an anger-induced laboratory and found that individual with higher in reappraisal had a more adaptive profile of emotional experience as well as cardiovascular responding compared to those who are low in reappraisal. Furthermore, those with higher in reappraisal also reported less anger, less negative emotion, and more positive emotion. These results are consistent with the previous research (i.e., McRae et al., 2008; Ochsner & Gross, 2005; Ochsner & Gross, 2008; Ray et al., 2010).

Though reappraisal seems to be the most promising strategies for regulating emotions, some of the evidence has been mixed. In particular, it appears that the effectiveness of emotion regulation strategies is not corresponding with the unfolding of emotional responses. For example, some forms of reappraisal are more effective when they are applied during emotion induction, rather than before (Urry, 2009). Moreover, the underlying mechanisms of reappraisal require individuals to be fully self-aware of their own feelings and be able to reinterpret the emotional events. This can lead to the draining of cognitive resources and individuals can become cognitively depleted (Schmeichel, 2007).

Attentional Distraction

Attentional distraction (also known as positive distraction, or positive refocusing) refers to a way in which individuals try to deploy attention away from the emotion-eliciting event. This strategy is believed to operate before an individual evaluate the meaning of emotional stimulus (Thiruchselvam et al., 2011). Distraction has been found to decrease negative emotions (Webb et al., 2012; a meta-analysis), particularly when associated with problem-focused coping. For example, a person may feel annoyed when the other person cut him in line after he has been waiting for a long time. However, before he becomes fully annoyed about the situation, he may distract himself and think about something else to alter that emotional outcome.

Distraction has been shown to reduce intensity of painful. Tracey et al. (2002) studied how diverting attention can reduce painful feelings. In the experiments, subjects were told to either focus on or distract themselves from the painful stimuli, which were cured using colored lights. Results showed that when participants diverted their attention away, they rated the pain intensity as significantly lower compared with when they focus on the stimulus. Moreover, Denson et al. (2012) compared the effect of analytical rumination, reappraisal, and distraction on anger experience. The results have shown that, while individuals in rumination condition remained angry, individuals in reappraisal and distraction conditions reported decreased anger significantly. Precisely, reappraisal facilitates adaptive processing of anger-inducing memories while distraction facilitates rapid reductions in anger experience.

Besides decreasing negative emotions, Lench et al. (2016) studied on biases arising from emotional processes including loss aversion, the desirability bias, risk aversion, and optimistic bias. In the experiments, they have participants read messages and made judgments. The studies found that when participants were told to "avoid thinking about feelings while making a judgment." Their judgments were less biased and more consistent.

Research has frequently compared distraction to thought suppression. Thought suppression is a way in which individual try to suppress unwanted thoughts. Wegner et al. (1987) instructed subjects to “try not to think of white bear” for five minutes. The results showed that subjects thought more of white bear than subjects in control group (think freely). However, focused-distraction has shown outcomes unlike thought suppression. Lin and Wicker (2007) compared focused-distraction to thought suppression and concentration and examined how anxiety were associated with the use of each thought-control strategies. Results showed that focused-distraction and concentration led to less thought occurring than thought suppression which suggests that focused-distraction works better than thought suppression in attempt to get rid of unwanted thought. Moreover, subjects in focused-distraction and concentration also reported lower anxiety during the tasks than those who were in suppression condition.

In spite of that, distraction is not a substitute for problem-solving, therefore, it is not the most effective way to resolve all types of negative emotions, especially those with complex and structural causes such as dissatisfaction in relationship or problem at work. Van Dillen and Koole (2007) suggested that distracting from a cause of negative emotion or emotional impact can contribute to a long-term maladaptive behavior. Furthermore, when distraction techniques are used repeatedly, evidence has shown that it reduced the positive emotion and cause more negative affect (Gross & Levenson, 1997).

Even though reappraisal and distraction occur at different processes in Gross's model, in literatures, the distinction between reappraisal and distraction is sometimes ambiguous. For example, one can either *change the way* he or she think about the situation (e.g., my husband threats me badly today because he has a bad day at work) or *change the subject* he or she is thinking entirely to alter the emotional outcome (e.g., my husband threats me badly today, I will go out and see my friends instead). These two examples are both considered reappraisal according to Gross and Thompson (2007)'s definition. However, to distinguish these two concepts, Garnefski et al. (2007) suggested the distinctive definitions for attentional distraction (aka positive refocusing) and positive reappraisal. Positive refocusing refers to thinking about joyful and pleasant issues instead of thinking about the actual event such as "I think of nicer things than what I have experienced" or "I think of something nice instead of what has happened." On the other hand, positive reappraisal refers to thoughts of creating a positive meaning to the event in terms of personal growth. However, Webb et al. (2012) mentioned that there are many forms of reappraisal across various emotion regulation research. They compared three reappraisal forms including *reappraise emotional response* —participants may be told that the emotion is normal or that they should accept or not judge the emotion, *reappraisal emotional stimulus* —participants might be asked to imagine that negative event has positive outcome, and *reappraise via perspective-taking* — participants may be told to view stimulus as detected observers. Results show that mixed reappraise has the most effective results on decreasing negative emotions (d = .89, 95% CI = .24 – 1.54).

Affect labeling

A newly introduced emotion regulation strategy by Lieberman et al. (2007) was affect labeling. Affect labeling is considered an implicit form of emotion regulation which refers to a way in which people try to name their feelings (e.g., I feel fear). This strategy involves solely verbally labeling the emotional content of an external stimulus or individual's affective responses without an intentional goal of changing emotional responses (Burklund et al., 2014).

Affect labeling has been shown to decrease negative emotions in many studies, for example, Lieberman et al. (2011) conducted experiments to examine the effect of affect labeling on self-reported emotional experience. Participants were asked to watch negative emotional pictures. Results showed that self-reported distress was significantly lower during affect labeling, compared to passive watching. However, researchers claimed that participants did not believe in affect labeling and predicted that affect labeling would increase negative feelings afterward. In other words, the participants did not recognize affect labeling as emotion regulation strategy. Therefore, Lieberman and colleagues describe affect labeling as an incidental emotion regulation process.

Research suggests that affect labeling also has long-lasting on emotional outcomes. Tabibnia et al. (2008) examined the effect of affect labeling on spider phobia. They recruited participants with spider phobia and assigned to three groups: exposure only, exposure with a negative label, and exposure with a neutral label. Even though there was no decrease in self-reported fear level, eight days after the initial exposure to spider pictures, the physiological result (skin conductance) indicated decreased arousal compared with the other two groups. Besides, skin conductance showed that participants in the negative label group were less sensitive to new spider pictures compared with their first exposure.

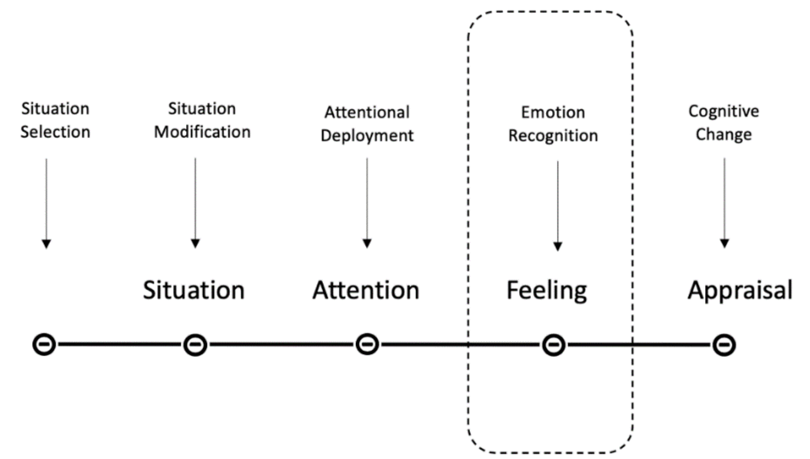
In addition to self-reported studies, Burklund et al. (2014) studied how affect labeling influenced emotional experiences compared to reappraisal in laboratory settings. The fMRI result showed that affect labeling decreased the activity of Amygdala, a part of the brain that is associated with emotions, and increased the activity of both ventrolateral prefrontal cortex (VLPFC) and dorsolateral prefrontal cortex (DLPFC) which are associated with reasons. These fMRI results are associated with the results of both reappraisal and distraction (Hariri et al., 2000; Lieberman et al., 2007). Moreover, the results from self-report also showed the correlation between affect labeling and reductions in distress (Burklund et al., 2014).

A recent study (Fan et al., 2019) examined the effect of affect labeling on online social media–Twitter by identifying Twitter timelines of 665,081 randomly selected subjects. They analyzed the emotional content of tweets by those twitters in the six hours before and the six hours after the affect labeling tweets. Results have shown that affect labeling dampens both positive and negative emotions. While negative emotions dropped rapidly after labeling, positive emotions remained for a while before starting to decline.

Even though affect labeling has shown to be effective to reduce negative emotions just like reappraisal and distraction, researchers still question where affect labeling belongs in the Gross's Process Model of Emotion Regulation. Moyal et al. (2014) proposes an additional stage of emotion regulation suggesting that affect labeling can occur before the cognitive change process, that is, emotion recognition. They claimed that "labeling itself is an emotion regulation strategy that helps to decrease emotional reactivity as see in various research" (Moyal et al., 2014, p. 2)

Figure 3

A Renewed Model of The Emotion Regulation Process, Based on Gross' Model and Moyal et al. (2014)



Torre and Lieberman (2018) explains that affect labeling is considered an emotion regulation because of its effect on decreasing negative emotions, even without a direct goal to control those emotions. They further outlined the possible mechanisms of affect labeling (i.e., distraction, self-reflection, reduction of uncertainty, and symbolic conversion) However, the underlying mechanisms of affect labeling have not been investigated directly. At this point, we could rely only on the evidence of affect labeling's effectiveness from fMRI studies and self-report.

The Effectiveness of Emotion Regulation Strategies

A meta-analysis of Webb et al. (2012) investigated the effectiveness of emotion regulation strategies regarding Gross's process model. A systematic search of the literature identified 306 experimental comparisons of different emotion regulation strategies. The findings discovered differences in effectiveness between the processes of emotion regulation. Results showed that cognitive change was significantly proven more effective than attentional deployment and response modulation. Moreover, when compared across 15 strategies, positive reappraisal mixed method has the most positive effect on emotional outcomes (d = 0.89) while active positive distraction has the second most positive effect (d = 0.56). Nevertheless, reappraisal and distraction are antecedent-focused strategies. Gyurak et al. (2011) suggests that antecedent-focused process is more effective in changing the intensity of emotions than response-focused process, because antecedent-focused strategies decrease the extent to which emotion response tendencies are activated, leading to lesser subjective, physiological, and expressive signs of negative emotion. In contrast, response-focused strategies target response tendencies that have been already produced (Gross & Thompson, 2007). Although Webb et al. (2012)'s did not include affect labeling. Lieberman et al. (2011) found affect labeling showed similar effects on self-reported distress as reappraisal and distraction. The effectiveness of reappraisal was stronger than affect labeling while distraction did not show significant different to affect labeling. However, Lieberman et al. (2011)'s methods compared only two strategies (i.e. affect labeling vs distraction, and affect labeling vs reappraisal). However, a comparison of the three strategies has rarely been studied directly.

Particularly, reappraisal decreased more self-reported distress than affect labeling whereas the outcomes of affect labeling and distraction were not significantly different. In addition to self-report questionnaires, neuroimaging studies also found that reappraisal, distraction, and affect labeling result in the same manner, that is, they all reduced amygdala activation coupled with greater prefrontal cortex activation (Giorgetta et al., 2012; Grecucci et al., 2012; Hariri et al., 2000; Moyal et al., 2014).

Limited Resources, Executive Controls, and Emotion regulation

Limited Resources

Baumeister et al. (2007) suggested that the amount of cognitive resources which an individual has is critical to any attempt at self-control. According to the Strength Model, after repeated self-control activities, individuals have less cognitive strength and are said to be in a state of mental depletion. Furthermore, the effort to control thought or behavior in one domain leads to reduced capacity in other domains. For example, Baumeister et al. (1998) conducted a series of experiments to see what happened to self-control in two consecutive tasks. They asked participants to inhibit their emotion while they were watching aversive clips. After that, participants were asked to perform cognitive tasks. The results showed that controlling one's emotions impaired performance on subsequent cognitive tasks. Subsequent work also yielded similar conclusions. In Vohs and Heatherton (2000)'s work, three experiments were conducted to test behavioral consequences of effortful regulation. First, participants with chronic inhibitions about eating were measured their ability to self-regulation. Then, they were exposed to good-tasting snack foods (Study 1 and 2) and were required to control their emotional expressions (Study 3). The results showed that exerting self-control during the first task led to a reduction in self-control on a subsequent task.

Executive Controls

Executive controls (also known as executive functions or effortful controls) has been defined as the conscious control of thought and action needed for purposeful behavior (Baddeley, 1998). Executive functioning is required for goal-directed behaviors and can be especially important for inhibiting automatic or established thoughts and responses including emotions. Core executive functions are inhibition such as self-control (resisting temptation or inhibit emotional expression), working memory (WM), and cognitive flexibility such as mental shifting. Using executive controls is effortful just like self-regulation. However, only a few works in literature demonstrate the shared resources of executive controls and self-regulation.

To test the hypothesis that executive controls also operate like a limited resource. Schmeichel (2007) examined initial efforts at executive control temporarily undermine subsequent efforts at executive controls. In the first experiment, he examined the effects of attention control on subsequent working memory span. One hundred forty-five participants were randomly assigned into two conditions: attentional control and control group. Participants in the attentional control condition were asked to “avoid looking at or reading any words that may appear on the screen.” The result has shown that participants who were instructed to control their attention while watching a video performed significantly worse on subsequent tests of working memory span compared with participants who were not told to control their attention. Subsequently, in the second experiment, Schmeichel replicated and extended the results from Experiment 1 to different executive controls tasks. Response inhibition tasks were used instead of attention control task. Sixty-one participants were recruited in this experiment. They were randomly assigned to the controlled writing condition that was instructed not to use the letters *A* or *N* anywhere in their story vs. the free writing condition. After six minutes of writing, they were asked to perform a reverse digit span task. This showed the consistent result to Experiment 1 that prior efforts at executive control undermine further attempt to perform executive control.

The results of previous mentioned work supported that executive controls share finite resources and indicated that cognitive fatigue impacts the performance of subsequent executive controls tasks. Schmeichel (2007) also suggested that initial efforts at executive control may not only impair later performances that rely on the same components of the cognitive functioning but also diminish the effectiveness of emotion regulation.

Cognitive fatigue and Emotion Regulation

Although emotion regulation has been studied apart from executive controls, research has been shown pieces of evidence that both acts rely on the same limited resource. For example, Wegner et al. (1993) examined the underlying of shared cognitive resources. They conducted experiments to test the impact of cognitive load on mood regulation. Participants were randomly assigned to cognitive load (vs. control) conditions. Participants in cognitive load condition were told not to feel any emotions (e.g. "don't let yourself feel sad.") while writing down their stream of consciousness including images, ideas, memories, feelings, fantasies, plans, sensations, observations. Then, all the participants would have to remember the number “741296835” to report to experimenter at the end of the experiment. The results have shown that the attempt to regulate negative emotions by thought suppression led to paradoxical increases negative feeling when cognitive load is high.

Previous research has shown that emotion regulation dampened cognitive ability. A series of studies by Richards and Gross (2000) examined the role of expressive suppression to working memory. They randomly assigned participants to two instructional conditions which are expressive suppression that required participants to inhibit emotional expression during the 140s clip and watch condition that required participants to passively watch the film clip. During the watching tasks, all participants were asked to remember visual and auditory information. They have found that expressive suppression impaired memory for the auditory information that had been played during an emotion-eliciting task.

Interestingly, in Richards and Gross (2000)’s second experiment they investigated cognitive costs for expressive suppression and reappraisal. In this study, participant watched emotion-eliciting slides under one of three conditions: watch only, expressive suppression, and reappraisal. Then, participants were asked to work on distraction tasks (verbal and math problem) for ten minutes before taking a paper-and-pencil cued recognition test. Results showed that only suppression led to poorer memory but not reappraisal.

Schmeichel (2007) conducted experiments that the subjects watched two short film clips that were intended to elicit emotions. Then, they were asked to exaggerate the outward responses or suppress the responses. Afterward, subjects were asked to work on working memory tasks. The results showed that when subjects were asked to either exaggerate or suppress their emotional responses, they performed the memory tasks poorer compared to those who were in a control condition. Consequently, he conducted later experiments to examine the reverse effect of the previous study. He predicted that exaggerating negative emotions would impair subsequent executive tasks. Subjects were asked to exaggerate or expressing negative emotions (vs. control). Later on, they were asked to do working memory span tasks. Results showed that exaggerating emotional expression undermined performance on following tests of working memory.

Grillon et al. (2015)'s experiment is consistent with Schmeichel (2007)'s results. They conducted experiments to investigate the effect of mental depletion to reappraisal. In the experiments, subjects were randomly assigned into two conditions: cognitive fatigue and no cognitive fatigue (control), following by having them reappraised emotional experience from IAPs pictures. Their work has shown that when the subjects were cognitively depleted, the effectiveness of reappraisal was significantly lower than the control condition.

These findings support the view that executive controls and emotion regulation rely on the same limited and depletable resource (Grillon et al., 2015; Schmeichel, 2007). Moreover, although research has illuminated this relationship, no study to date has examined the effect of cognitive fatigue on specific emotion regulation strategies, or vice versa, other than reappraisal. Although research has supported the effectiveness of reappraisal, the individual who tries to reappraise negative emotions may fail due to cognitive demand of it (Schmeichel, 2007). Therefore, I select two more strategies (i.e., positive distraction and affect labeling) to examine whether and to what extent they will be affected by cognitive fatigue. According to Webb et al.'s meta-analysis (Webb et al., 2012), positive distraction is the second most effective strategy to decrease negative emotion. Furthermore, affect labeling is introduced in this research for the reason that some researcher considers affect labeling to be a form of implicit emotion regulation (Torre & Lieberman, 2018). Koole and Rothermund (2011) mentioned that "a defining characteristic of implicit emotion regulation is that it does not require conscious supervision or explicit intention, yet still alters an emotional experience." Even though, affect labeling is not effortless as it does require a conscious recognition of one's state of emotions (Koole & Rothermund, 2011, p. 389). They view affects labeling as implicit emotion regulation which requires less effort. This lead to a prediction that the effectiveness of affect labeling may not be diminished by cognitive fatigue.

Utilization of Physiological Responses in Measuring Emotional Responses

Skin Conductance (SC) (also known as Electrodermal Activity (EDA) or Galvanic Skin Response (GSR)) is a term used for defining variations in electrical conductivity which can be measured across the surface of human's skin. Change on conductivity is attributed to changes in the activity of the autonomic nervous system — the part of the nervous system responsible for the control of the bodily functions not consciously directed such as heart rate, digestion, and blood pressure. SC originates from the autonomic activation of sweat glands in the skin which is controlled by the sympathetic nervous system —the system that activates what is often termed the fight or flight response. SC relies on the amount of moisture produced by eccrine sweat glands. With increased sympathetic activation, eccrine glands produce more moisture, therefore increasing conductivity of the skin. As such, with increased stress, anxiety, or any emotion-related arousal, skin conductance increases (Kreibig, 2010).

Skin conductance is measured in microSiemens (uS). In psychological research, Skin conductance is used to identify how humans respond emotional towards various stimuli and how these responses are affected by stimuli properties such as color, shape, and duration of the presentation, personality characteristics such as extravert vs. introvert (Williams et al., 2005). The skin conductance data can be quantified statistically (Boucsein et al., 2012) and consist of two main components: SCL and SCR. SCL refers to “Skin Conductance Level” also known as tonic level. This response slowly changes within tens of seconds to minutes. The rising and declining SCL is constantly changing within an individual respondent, depending on their physiological conditions (e.g. hydration, skin dryness, autonomic regulation). SCL also varies upon individual differences, therefore, the actual tonic level on its own is not very informative. SCR refers to “Skin Conductance Response” also known as the phasic response. Unlike SCL, SCR changes significantly faster. Variations in the phasic responses are observable as "GSR bursts" or "GSR peaks" which occur within 1-5 seconds after the onset of a stimulus. The phasic response is very sensitive to specific emotionally arousing stimulus events. If the SCR appears in response to a stimulus within 1-7 second, then it is referred to as an Even-Related SCR (ER-SCR), while if it appears without any emotion-eliciting cause, it's referred to as a Non-Specific SCR (NS-SCR).

In order to analyze Skin conductance data, the first step is to average the data (typically, the phasic response) which can be done by splitting the data into discrete phase and then averaging the values that are present within that timeframe. By comparing these data, this physiological measure gives insight into how individual’s reactions to different stimuli might take place or how variations occur between different individuals in response to the same stimulus. However, the SC data provides a measurement of how strongly an emotion was experienced, not the direction of the emotion, therefore, it is often used with self-report emotion questionnaire (e.g. Positive and Negative Affect Schedule (PANAS; Watson et al., 1988).

Critical Analysis of Current Literature

The first aim of this study is to assess and compare subjective feelings and skin conductance responses of reappraisal, distraction, and affect labeling. Previous research has compared the effectiveness of two strategies such as reappraisal vs. distraction (Bettis et al., 2018; Kross & Ayduk, 2008; McRae et al., 2010; McRae et al., 2008; Sheppes & Meiran, 2007; Strauss et al., 2016), distraction vs. affect labeling, and affect labeling vs. reappraisal (Lieberman et al., 2007). My purpose is to compare directly the effectiveness of the three strategies. I predict that reappraisal will be the most successful strategy to reduce negative emotions, following by distraction and affect labeling respectively.

Hypothesis 1: In non-fatigue condition, reappraisal will decrease negative feelings more than distraction and affect labeling, respectively.

The second aim of this study is to examine whether cognitive fatigue leads to emotion regulation failure in reappraisal, distraction, and affect labeling compare to non-fatigue condition. According to Schmeichel (2007)'s, exhausted executive control could dampen performance of subsequent emotion regulation tasks. I predict that, in consistent with previous literature, reappraisal will be less effective in regulating negative emotions in the cognitive fatigue condition than in the non-fatigue condition due to its demand for cognitive resources. Reappraisal is an intentional and effortful strategy that requires individual to be fully aware of their emotional experiences and reinterpret the situations. Opitz et al. (2014) suggested that fluid cognitive ability is a resource for successful emotion regulation in both old and young adults. individuals with higher fluid cognitive ability (i.e. perceptual reasoning, processing speed, and working memory) was correlated with greater success using reappraisal to change emotional experience. Schmeichel (2008) also found that people with higher in working memory capacity are more capably appraised emotional stimuli in an unemotional manner and thereby experienced. Research has also found that attempting to regulate emotions via reappraisal slowed performance and reaction time (Ortner et al., 2013). These can conclude that reappraisal requires some amount of cognitive effort. Second, distraction will also be affected by cognitive fatigue, however, less than in reappraisal. Research has found that different patterns of visual attention were associated with successful emotion regulation and reappraisal was found to demand more of attention compared to distraction during emotional eliciting pictures (Strauss et al., 2016). Moreover, distraction can establish before individuals assess the emotional information, therefore, emotional awareness is not necessary. Lastly, though cognitive demands of affect labeling have not been explored using the same paradigm, I predict that affect labeling will not be affected by cognitive fatigue since affect labeling does not require intention and goal to down-regulate negative emotion. Although affect labeling is not effortless, it may demand very less cognitive resources than reappraisal and distraction.

Hypothesis 2: Cognitive fatigue will generally dampen the effectiveness of all emotion regulation strategies, however, cognitive fatigue will differently diminish the effectiveness of each strategy.

Taken together, the last aim is to compare the effectiveness of reappraisal, distraction, and affect labeling in response to cognitive fatigue. I predict that distraction will be the most successful strategy to decrease negative emotions. Following by affect labeling and reappraisal respectively.

Hypothesis 3: In fatigue condition, distraction decreases negative feelings more than affect labeling and reappraisal, respectively.

In this present study, the first independent variable, emotion regulation strategies, consists of three levels: reappraisal, distraction, and affect labeling. The second independent variable, cognitive fatigue, contains two conditions: no fatigue, and fatigue. The two dependent variables are the self-reported emotion intensity and skin conductance response.

Chapter 2

Methods

This study was conducted in 3 x 2 within-subject factorial design to examine the effectiveness of emotion regulation strategies including reappraisal, distraction, and affect labeling to negative emotions in response to cognitive fatigue.

Participants

Forty-nine participants (41 female) were recruited through classes and social network (e.g., Facebook). Participants ranged in age from 18 to 29 years (M = 22.4, SD = .65; see **Table 1** for details). They received a compensation of 200 Baht (≈$6) for their participation. A incomplete block design for a 3 (strategies) by 2 (fatigue) within-subject conditions was employed in order to reduce the length of the experimental session and kept the participants engaged. In this design, one participant was randomly assigned into 4 of 6 conditions, resulting 30 observations from 45 participants for the entire design (See **Figure 4**).

Table 1

Demographic Information

		n	%
Gender	Men	8	16.33
	Women	41	83.67
	Total	49	100
Education	Undergraduate	28	57.14
	Graduate	9	18.37
	Other	12	24.49
	Total	49	100

Data from 3 individuals were excluded from the analysis due to non-responses of skin conductance that occurred during the experiment. Thus, the final sample was 46 participants.

The exclusion criteria were

1) below 18 year-old or above 30 year-old;
2) consumed alcohol within 24 hours or coffee within 3 hours prior to the experiment;
3) insensitive to skin conductance device;
4) did not understand how to regulation emotions after a training session; or
5) refused to give an informed consent.

Figure 4

Randomized Incomplete Block Design for 4 Conditions per Person (out of 6 Conditions) before Counterbalancing, Results 15 Blocks. (Fisher, 1960)

Block	1	2	3	4	Block	1	2	3	4	Block	1	2	3	4
(1)	1	2	3	4	(6)	1	2	3	5	(11)	1	3	5	6
(2)	1	4	5	6	(7)	1	2	3	6	(12)	2	3	4	6
(3)	2	3	5	6	(8)	1	3	4	5	(13)	1	2	5	6
(4)	1	2	3	5	(9)	2	4	5	6	(14)	1	3	4	6
(5)	1	2	4	6	(10)	1	2	4	5	(15)	2	3	4	5

Materials

Emotional Stimuli

Seventy pictures from the International Affective Picture System (IAPS; Lang et al., 2008) were rated by 33 individuals in the pilot study using the Self-Assessment Manikin (SAM; Bradley & Lang, 1994), a non-verbal assessment technique in pictorial form that directly measures the valence, arousal, and dominance associated with a person's emotional response to stimuli. The SAM is typically used to measure emotional states after seeing emotion-eliciting stimuli. The SAM comprises single-item scales that measure valence of the response (7 = positive to 1 = negative), perceived arousal (7 = high to 1 = low levels), and perceptions of dominance/control (1 = low to 7 = high). the SAM was used to assess the valence and arousal of pictures from the IAPS in a pilot study. Negative pictures were categorized by valence rating between 3.5 to 5 and the arousal rating between 1 to 3; neutral pictures had valence between 1 to 3.5 and arousal between 4.3 to 7. Thirty negative pictures were used as experimental stimuli (15 for fatigue condition, 15 for non-fatigue condition; see **Table 2** for IAPS number). These pictures consisted of mixed negative emotions including fear, disgust, and sadness. Five negative and five neutral pictures were selected as baseline-controls. Blocks of pictures were randomly assigned into conditions and the pictures were randomly presented within the condition, except for a block of neutral pictures that always appeared in the first sequence.

Preliminary Analysis of Stimuli

A preliminary analysis of stimuli showed that 33 participants (age: between 18 – 30 years old) rated valence and arousal of IAPS pictures. An analysis of variance showed no significant difference among 7 blocks of pictures ($F(1,6) = 0.196$, $p = 0.975$). Means and standard deviations of each block were shown in **Table 2.**

The self-reported subjective intensity of neutral pictures ($M = 1.57$, $SD = 0.82$) is significantly lower than negative pictures ($M = 4.14$, $SD = 1.18$; $t(45) = -16.13$, CI [-2.89, -2.25], $p < 0.001$).

Table 2

Mean and Standard Deviation of Pictorial Stimuli for Each Block

block	Number of IAPS picture	*M*	*SD*
1	3001, 1271, 1525, 1301, 1202	4.83	0.62
2	9187, 1270, 1050, 6231, 8370	4.90	0.56
3	9163, 1114, 2345.1, 1051, 1022	4.78	0.30
4	1932, 9940, 1040, 1052, 1026	4.72	0.38
5	3005.1, 1033, 1280, 1310, 8192	4.85	0.40
6	1274, 1726, 8186, 8192, 1811	4.64	0.47
7	1111, 1300, 1930, 1019, 1201	4.81	0.34

Note: Neutral pictures consists of 5 pictures: 7000, 7004, 7009, 7025, 7090

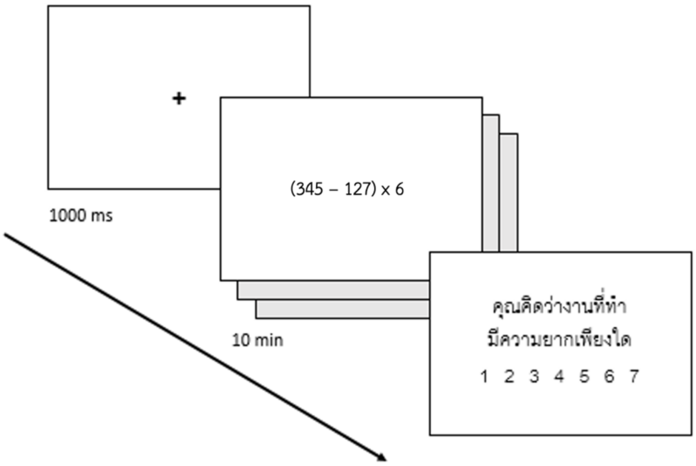
Tasks

Fatigue Task

Fatigue task consisted of a series of mental calculations including additions, subtractions, multiplications, and division which consists of 1 – 3 digit numbers and three levels of calculation, for instance, (345-127) x 6. For non-fatigue conditions, the calculation consists of 1 – 2 digits number and two levels of calculation (e.g., 12 + 7). This task derives from Hagger et al. (2010) and has been frequently employed in fatigue studies and require significant effort to maintain a high level of executive functioning. These tasks are 10 minutes apart for each condition and last ten minutes.

Figure 5

Fatigue Task Procedure



Emotion Regulation Tasks

Emotion regulation tasks required individuals to regulate their emotions which were elicited by IAPS pictures. The instructions derived from a meta-analysis of Webb et al. (2012) and Lieberman (2011).

Before each emotion regulation task, participants were trained for each strategy by watching instructional video clips. The instructions below were demonstrated in the video clips.

For reappraisal condition, the instruction was, "Thoughts and feelings are associated. If you change your thoughts, your feelings may change accordingly. In this experiment, try to change your initial feelings toward the pictures by changing your thoughts. For example, you may feel fear toward a snake in the picture. If you try to think of benefits of snakes in the ecosystem (e.g., snakes help to eliminate excessive number of mice), this may lead you to changing your feeling. Or you could think of the snake picture as ‘a picture’ which does not have power over you”. (Gross, 1998). Cognitive change showed larger effect size than the others (*d* = .89, 95% CI = .24 – 1.54).

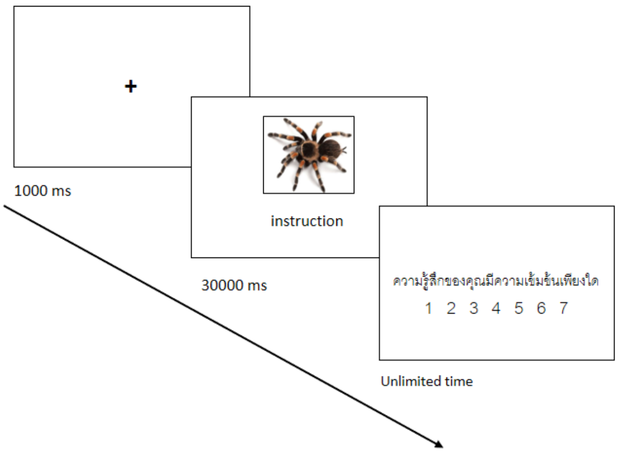
For positive distraction condition, the instruction was, “Thinking about something that is not relevant to things that may upset you could help you to experience less negative emotions. In this experiment, try to think about events that make you happy. For example, while seeing a picture of snake, you may try to think about the moments that you feel happy, such as, successfully get into a university of your choice, or you may think about the things that you like such as songs, movies, or favorite meals”. Positive distraction showed medium effect size on emotional outcomes (*d* = .56, 95% CI = .19 - .92).

For affect labeling condition, the instruction was, “Being aware of your feelings may lead you to experience less negative emotions. In this experiment, try to name your feelings toward the pictures. If those emotions are complex, for example, if you are experiencing both fear and disgust, you may choose the more intense one”. Participants were asked to fill in a blank space under pictures. Affect labeling showed a larger effect size than the control group (*d* = .81; Lieberman et al., 2011). Nevertheless, In Lieberman et al. (2007)’s experiment, he asked participants to choose between two emotional words (e.g., scary or angry), thus, the choices were more easily distinguishable. In this experiment, participants were asked to think about their emotions on their own, therefore, the effect might not be effortless as in Lieberman's work.

After a training session, participants were presented the three emotion regulation tasks in a random order. For cognitive reappraisal, the participants saw "เปลี่ยนความคิด" (transl. "change your thoughts"); for distraction, "คิดถึงสิ่งอื่น" (transl. "think something else"); and for affect labeling, "นึกถึงชื่ออารมณ์" (transl. "name the emotion"). Each emotion regulation condition consisted of five IAPS pictures and lasted 30 seconds per picture. At the end of each picture, participants completed the intensity of negative emotions rating. See **Appendix C** for full Thai instructions in the video clips.

Figure 6

Emotion Regulation Task Procedure



Measures

Physiological Activity

Skin Conductance Response (SCR) was utilized as the physiological measure of negative emotional arousal. SCR was recorded by The ProComp infiniti: Electrodermal Activity device (EDA) device from Thought Technology Inc. Skin conductance signals are transmitted using two electrodes attached to the ring and middle fingers of the non-dominant hand. The raw EDA signal provides two distinct sets of data: Skin Conductance Level (SCL) and Skin Conductance Response (SCR). EDA has been used in several emotion regulation studies (e.g., Kircanski et al., 2012; Matejka et al., 2013; Sperduti et al., 2017). In this research, the sum of amplitudes of phasic skin conductance response was an outcome variable of skin conductance analysis.

Self-reported Negative Emotions

Negative emotions was assessed by the subjective Intensity of negative emotions — a rating scale question assessing the participant's subjective emotional experience. “ความรู้สึกของคุณมีความเข้มข้นเพียงใด” (transl. “how intense was your feeling?” ranging from 1 = ไม่รู้สึกอารมณ์ทางลบเลย [transl. *did not feel any negative emotion at all*] to 7 = รู้สึกอารมณ์ทางลบอย่างมากที่สุด [transl. *strongly felt negative emotions*]). The item was presented following each IAPS picture. This measure derived from Sperduti et al. (2017)’s work that was used to assess the subjective emotional intensity of participant’s emotions for each pictorial stimulus.

Self-reported Difficulty of Tasks

The difficulty of tasks was assessed by a rating scale question “คุณคิดว่างานที่ทำมีความยากเพียงใด” (transl. “how difficult was the task?”) ranging from 1 (ไม่มีความยากเลย [transl. *the task was not difficult at all*] to 7 (มีความยากอย่างมากที่สุด [transl. The task was strongly difficult]) following cognitive fatigue task.

Procedures

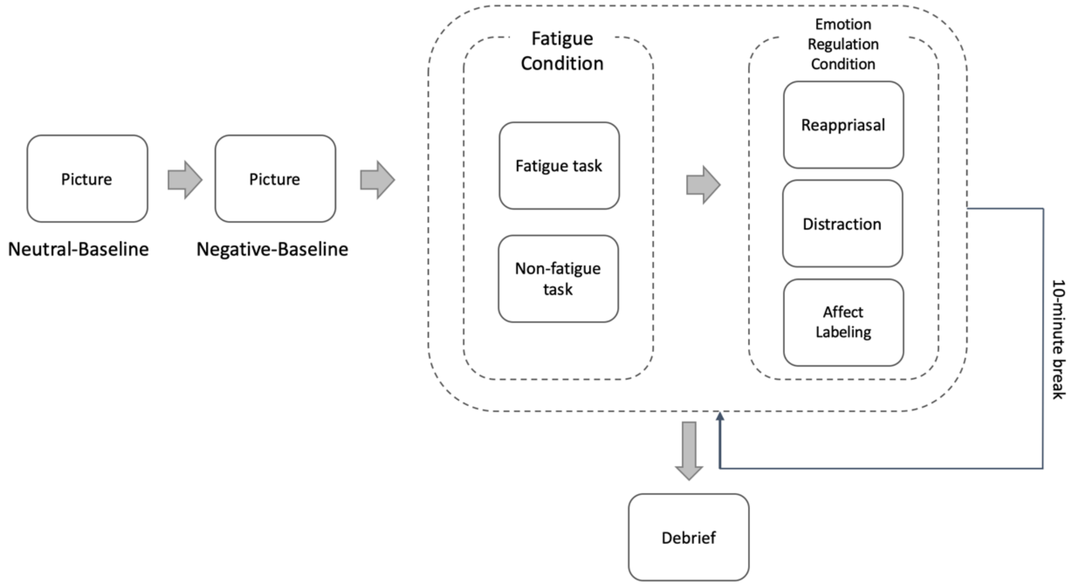
This experimental design consisted of 6 conditions: 2 fatigue conditions x 3 emotion regulation strategies. After giving informed consent and being screened for exclusion criteria, SCR electrode were placed on the distal phalanges of the first and middle finger of a participant’s non-dominant hand. Next, participants completed two baseline-control emotion regulation tasks: one with 5 neutral pictures and one with 5 negative pictures, respectively. An incomplete block design was, then, used to deliver a 2 (fatigue condition) × 3 (emotion regulation strategies) within-subject conditions as described above. Each participant would complete 4 out of 6 conditions. The assigned conditions were arranged into the fatigue condition set or the non-fatigue condition set. Participants either completed the all strategies in the fatigue condition set first then the non-fatigue condition set, or vice versa. This was done to ensure a smoother experimental procedure. Between the two set, participants were given a 10-minute rest.

In the fatigue condition set, participants began with the cognitively demanding mental calculation for 10 minutes and then, rated the difficulty of the task. After that, they completed each of the assigned emotion regulation strategy condition in succession. Within each strategy condition, they were presented with an instructional video pertaining to the assigned strategy. While watching the videos, participants were allowed to ask questions if they did not understand the instructions. They were also told that they should not close their eyes or look away from the pictures. Subsequently, in each regulation strategy condition, the participants regulated their emotional responses to five randomly-presented IAPS pictures using the strategy described on the screen. The self-report negative emotions rating was collected at the end of each picture. The non-fatigue condition set followed the same patterns, albeit employing the less cognitively demanding calculation task. The experimental stimuli were delivered via E-Prime 3.0 (Psychology Software Tools).

At the end of the experiment, participants were asked manipulation check questions (e.g., “what images did you see?” and “how did you regulate emotion via each task?”) and were debriefed at the end of experiments. Finally, all participants received their compensation and thanked for the participation.

Figure 7

Overview of the Procedure



Data preprocessing and data transformation

Skin Conductance Analysis

For the skin conductance analysis, many different software and programs were used. These programs were written in MATLAB and used for the transformation of the data analysis. After the experiment had done, raw skin conductance data were exported from BIO-graph program and renamed to P01- P46. Soon after that, these raw data were imported into Ledalab.GUI (Benedek & Kaernbach, 2010); a software for the analysis of skin conductance data in MATLAB program which is a multi-paradigm numerical computing environment and language programming developed by MathWorks (MATLAB, 2018) in order to transform and analyze data.

Preprocessing. SCR signal errors were characterized a drop or rise more than 4 standard deviations and were replaced using cubic interpolation method. These errors typically occurred when participants moved their hands during the session. Subsequently, the data were smoothed using Gauss Window method at $\alpha = 8$. The data were, then, down-sampled from 256Hz to 32Hz.

Event-related analysis. A continuous decomposition analysis (CDA) was used to extract the SCR Phasic information of each emotion regulation task. This analysis could provide various outcomes for each event (e.g., average phasic driver, area of phasic driver, number of skin conductance response onset, and sum of SCR-amplitudes of significant SCRs). In this study, sum of amplitudes of significant skin conductance response within each emotion regulation task was used as a dependent variable because sum of amplitudes better represents the magnitude of emotional activities than a number of skin conductance response onset, which only suggests the frequency of significant activity during the emotion regulation tasks. A minimum amplitude threshold of 0.01 uS[1] was used in this analysis. These event-related analyses were carried out in Lebalab. The event markers indicate the window of each tasks were set. A minimum amplitude threshold of 0.01 uS was used.

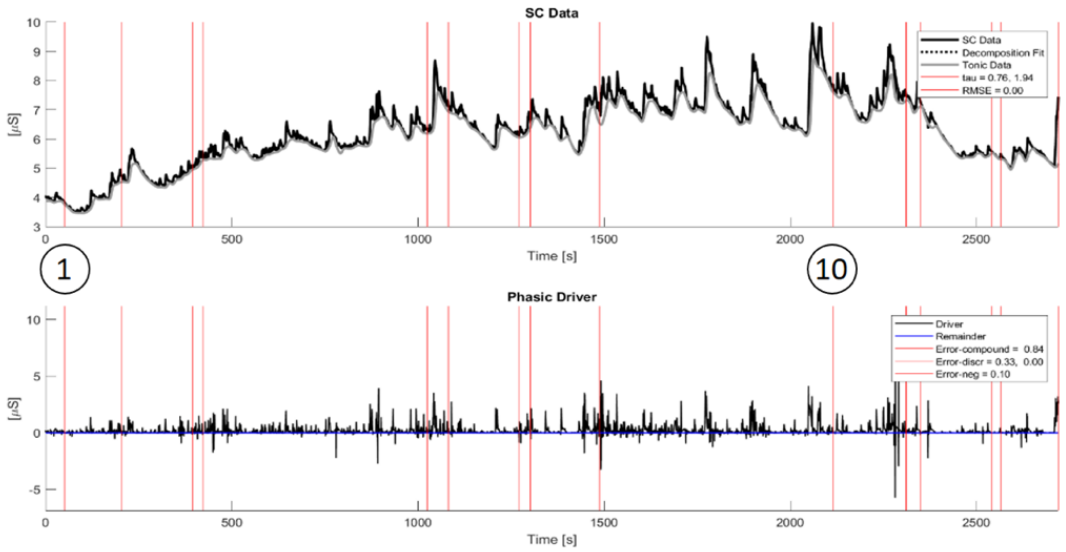
Data Transformation. Analyzed sum of amplitudes data were standardized into z-scores for each person simultaneously because the magnitude of skin

[1] microSiemens

conductance data can vary between individuals not only due to psychological but also due to physiological causes (Stemmler & Wacker, 2010). Then, Tukey's Ladder of Powers transformation was applied to transform sum of amplitudes data to approach a normal distribution.

Figure 8

Sample of Event-related Analysis on Ledalab



Note. The vertical red lines represent each event marker, for example, the red line number 1 is the first event that occurs during the experiment and the red line number 10 represent the third emotion regulation strategy.

Self-reports Analysis

Self-report of negative emotions score was exported from E-merge, a subset program from E-prime 3.0 program. The data contained multiple blocks according to participants' condition. Raw score from each block were calculated to means for each condition, these include the difficulty of the task, control blocks (neutral and negative, and emotion regulation blocks (reappraisal, distraction, and labeling).

All statistical analyses were performed using the open-source language R 3.6 (R development Core Team, 2019). Linear mixed-effect modeling (Bates, 2005), performed by lme4 package (Bates et al., 2014), was used in order to test the effect of each emotion regulation strategies. Linear mixed-effect models contains fixed effect (explanatory variables) and random effects (variance components). Furthermore, MuMin package (Barton, 2020) was used to calculate overall variances of the statistical models.

Chapter 3

Results

Manipulation Check

A dependent *t*-test showed that the difficulty of the tasks score in fatigue condition (M = 4.98, SD = 1.74) is significantly higher than non-fatigue condition (M = 1.70, SD = 0.84), $t(45) = 13.45$, 95% CI [2.79, 3.77], $p < 0.001$.

Outliners and Missing Data

Outlier Analysis

An outlier analysis was performed using the Interquartile Rule. For sum of amplitudes data, results showed that 25 outliers appeared above the interquartile range. These outliers were replaced using a winsorizing method. For self-report data, no outliers were found above or below interquartile range. Later on, Cook's Distances were calculated to estimate the influence of data in a set of predictor variables. However, results showed that there was no data with significant studentized residuals when testing by Bonferroni adjustment ($p < 0.05$).

Missing Data

Four missing data from 2 participants appeared due to an error of the skin conductance device. These 4 data were left missing in the datasets because the estimation procedure of the mixed model can robustly handle missing with maximum likelihood estimation method (McCulloch, 1997).

Data were examined for normality before analyses were performed. Self-report negative emotions data were normally distributed, whereas the sum of amplitudes had skewed and kurtotic distributions. Hence, Tukey's Ladder of Powers transformation was applied to transform sum of amplitudes data to approach a normal distribution.

Results of Self-reported Measure and Sum of amplitudes

Table 3

Means and Standard Deviations (in Parentheses) for the Two Dependent Measures in all Conditions.

Conditions	Strategies	Self-Report (*N* = 46)	Sum of Amplitude (uS) *(N = 45)*
Control	Control	4.14 (1.18)	1.53 (0.32)
Fatigue	Reappraisal	2.60 (1.17)	1.54 (0.38)
Fatigue	Distraction	2.69 (1.34)	1.72 (0.56)
Fatigue	Labeling	3.19 (1.29)	1.92 (0.70)
Non-fatigue	Reappraisal	2.19 (0.90)	1.50 (0.33)
Non-fatigue	Distraction	2.53 (1.14)	1.64 (0.46)
Non-fatigue	Labeling	3.34 (1.29)	1.77 (0.60)

Note. uS or microSiemens stands for the unit of skin conductance

Comparison of Emotion Regulation Strategies against Control Group

Linear mixed-effect models were designed to predict each of the outcome variables: self-report negative emotions and sum of SCR phasic amplitude.

In this first set of models, the strategies including negative baseline-control, and reappraisal, distraction, labeling in both fatigue and non-fatigue conditions were entered as fixed factors, whereas participants' ID were entered as a random factor.

Overall, the results of a random intercept showed that the self-report negative emotions in all six experimental conditions were significantly lower than the negative baseline-control (M_{exp} = 2.19 – 3.34 vs. $M_{neg\text{-}base}$ = 4.14). While the sum of amplitudes, only reappraisal in non-fatigue condition (*M* = 1.50, *SD* = 0.33) showed the result lower than the negative baseline control (*M* = 1.53, *SD* = 0.32). See **Table 4** for the model's coefficients.

One of the main differences between the two outcome variables was that, in the negative baseline-control, the sum of amplitudes was unexpectedly low. However, when examining the patterns of the six experimental conditions, self-report negative emotion and sum of SCR amplitudes followed the same trend (see **Figure 9 and 10**). The effects of experimental conditions on both outcome variables was analyzed in the next section.

Table 4

Random Intercept Model for Seven Conditions Nested in Participants

Predictor		Self-report			Sum of Amplitudes		
Conditions[a]	Strategies	*estimates*	*SE*	*t*	*estimates*	*SE*	*t*
	(Intercept)	4.14	0.17	23.78***	- 0.70	0.02	- 28.65***
Fatigue	Reappraisal	- 1.61	0.21	- 7.64***	- 0.01	0.04	- 0.12
Fatigue	Distraction	- 1.45	0.20	- 7.32***	0.04	0.04	1.13
Fatigue	Labeling	- 0.88	0.20	- 4.34***	0.13	0.04	3.46**
Non-fatigue	Reappraisal	- 2.00	0.21	- 9.51***	- 0.00	0.04	- 0.03
Non-fatigue	Distraction	- 1.60	0.21	- 7.58***	0.05	0.04	1.18
Non-fatigue	Labeling	- 0.72	0.21	- 3.43***	0.06	0.04	1.65
		Random Effects			**Random Effects**		
		σ^2 = 0.76			σ^2 = 0.02		
		$\tau_{00\ id}$ = 0.63			$\tau_{00\ id}$ = 0.00		
		Conditional R^2 = 0.588			Conditional R^2 = 0.055		
		Marginal R^2 = 0.247			Marginal R^2 = 0.055		

Note. * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

[a] The negative baseline-control group was coded as a reference condition

Figure 9

The Figure Shows Self-Report Negative Emotions for Each Emotion Regulation Strategy.

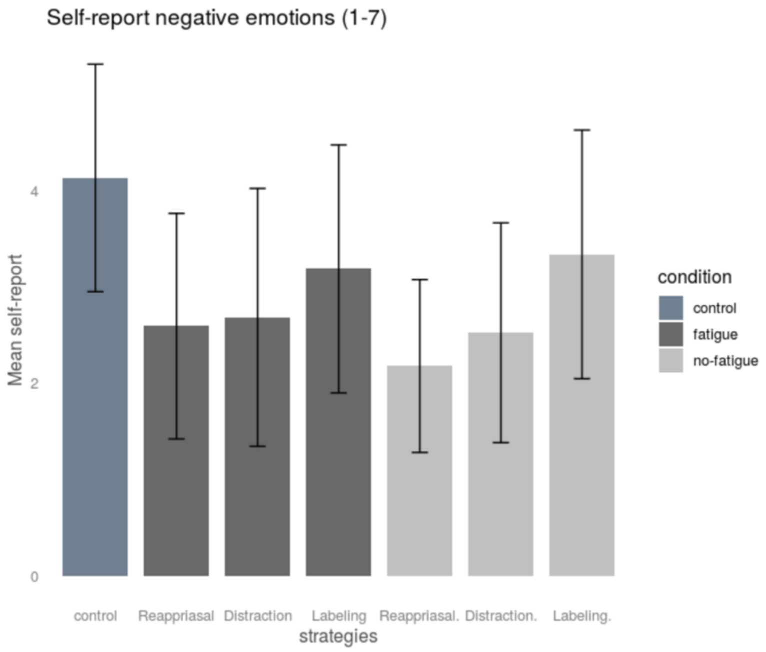
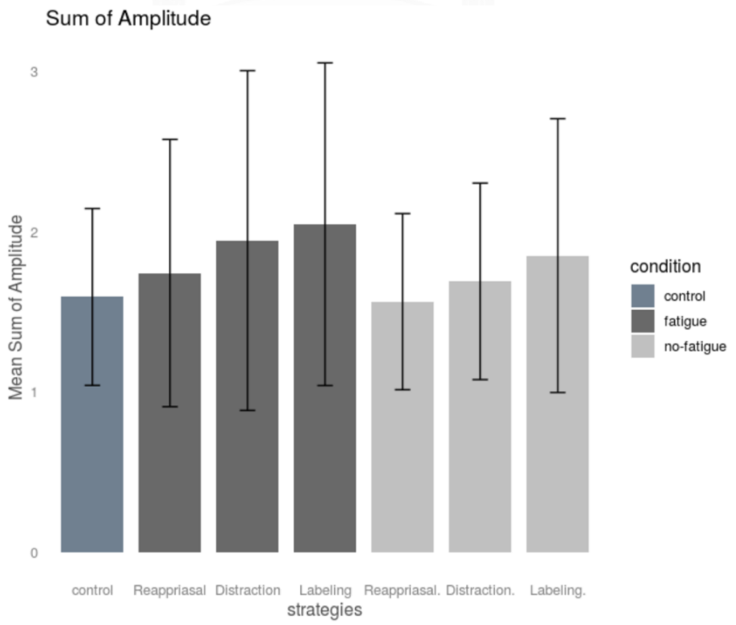


Figure 10

The Figure Shows Standardized Sum of Amplitudes for Each Emotion Regulation Strategy Measured by Skin Conductance Device.



Comparisons of Emotion Regulation Strategies and Fatigue Conditions

The second part of the analysis focused on comparing the effect of experimental groups. The cognitive fatigue conditions (fatigue and non-fatigue) and the strategies (reappraisal, distraction, and labeling) were entered as fixed factors, and participants' ID were entered as a random factor.

Self-Reported Negative Emotions

The overall of this model explained 58.8 % (the conditional R^2) of the subjective intensity variance, while the fixed factors explained 11.6 % (the marginal R^2) of the variance. The results revealed that the difference between the fatigue and non-fatigue conditions was not significant (b = - 0.36, t = -1.62 p = .106). For the main effect, affect labeling is significantly higher than reappraisal (b = 0.70, t = 3.23, p < 0.001) while distraction is not significantly different from reappraisal (b = 0.22, t = 1.01 p = 0.304). Furthermore, the interaction between emotion regulation strategies and cognitive fatigue was not significant. The result of likelihood ratio of the main effect model and the interaction effect was not significantly different (χ^2 (2) = 3.70, p = 0.16).

Sum of Amplitudes

The overall model predicting sum of amplitudes explained 5.65 % (the conditional R^2) of the variance and explained 5.65 % by fixed factors (marginal R^2). Consistent with the self-report negative emotions, the effect of cognitive fatigue was not significant for the sum of amplitudes (*b* = -0.01, *t* = -0.11, *p* = 0.915). Similarly, affect labeling showed a significant difference to reappraisal (*b* = 0.09, *t* = 2.39 *p* < 0.05) while distraction showed no significant difference (*b* = 0.03, *t* = 0.85 *p* = 0.395). There was no significant interaction between the fixed factors. The result of likelihood ratio of the main effect model and the interaction effect model also showed no significant difference (χ^2 (2) = 0.50, *p* = 0.78). The full results are shown in **Table 5.**

Table 5

Random Intercept Model for Fatigue Conditions and Strategies nested In Participants

Predictors[a]	Self-report			Sum of Amplitudes		
	estimates	*SE*	*t*	*estimates*	*SE*	*t*
(Intercept)	2.50	0.2	12.403***	- 0.72	0.03	- 25.94
Condition [non-fatigue]	- 0.36	0.31	-1.62	- 0.01	0.04	-0.11
Distraction	0.22	0.21	1.01	0.03	0.04	0.85
Labeling	0.70	0.22	3.23***	0.09	0.04	2.39*
Distraction * non-fatigue	0.29	0.31	0.64	0.01	0.56	0.20
Labeling * non-fatigue	0.59	0.31	1.89	- 0.03	0.06	- 0.47
	Random Effects			Random Effects		
	σ^2 = 0.65			σ^2 = 0.02		
	$\tau_{00\ id}$ = 0.75			$\tau_{00\ id}$ = 0.00		
	Conditional R^2 = 0.588			Conditional R^2 = 0.057		
	Marginal R^2 = 0.116			Marginal R^2 = 0.057		

Note. * = *p* < 0.05, ** = *p* < 0.01, *** = *p* < 0.001

[a] The fatigue condition and reappraisal were coded as reference groups

Additional Analysis[2]

The previous linear mixed effect models have shown that the sum of SCR amplitudes was unexpectedly low in the negative baseline-control tasks. The author suspected that this could be due to the carry-over effect that led experimental conditions to have higher score of the sum of amplitudes. This additional analysis result showed that the effect of times in which participants implemented the strategies were not significantly difference (b = 0.01, t = 0.87, p = 0.384). The result of likelihood ratio of the null model and the times-covariate model showed no significant difference (χ^2 (1) = 0.77, p = 0.38). The full results are shown in the **Appendix F**.

[2] I would like to thank the committee for suggesting this additional analysis

Chapter 4

Discussion

The aim of this research was to investigate the extent cognitive fatigue influences on emotion regulation, along the interaction between cognitive fatigue and the three emotion regulation strategies: reappraisal, distraction, and affect labeling.

Summary of Self-reported Negative Emotions

Reappraisal, distraction, and affect labeling were effective in decreasing negative emotions than the negative baseline-control group. Furthermore, the effectiveness of reappraisal, distraction, and affect labelling were not influenced by cognitive fatigue. However, results showed that reappraisal and distraction were significantly more effective than labeling in both fatigue and non-fatigue condition. Interaction effect was not found in these results.

Summary of Sum of Amplitudes

Reappraisal decreased negative emotion more effectively compared to negative baseline-control group in both fatigue conditions. However, results showed that distraction was slightly higher than control group while affect labeling was higher than control group significantly. This suggested the inconsistency between self-reported negative emotion and sum of amplitudes’ results. Moreover, the effectiveness of the three emotion regulation strategies was not significantly affected by cognitive fatigue. Interaction effect was not found in these results.

Discussion of the Results

As anticipated, reappraisal seems to be more efficient in decreasing negative emotions than distraction and affect labeling in non-fatigue condition. Additionally, distraction diminished negative emotions more than affect labeling. More specifically, the results showed when responding to negative pictures without cognitive fatigue, reappraisal outperformed both distraction and affect labeling.

These finding **supported the first hypothesis** that in non-fatigue condition, reappraisal will decrease negative feelings more than distraction and affect labeling, respectively.

In fatigue condition, the author hypothesized that reappraisal would decrease lesser intensity of negative emotions compared to distraction and affect labeling. The results showed that the three strategies were not influenced by cognitive fatigue, yet, the effectiveness of reappraisal remained outstanding compared to distraction and labeling.

Thus, the results **did not support the second hypothesis** that cognitive fatigue would generally dampen the effectiveness of all emotion regulation strategies, however, cognitive fatigue would differently diminish the effectiveness of each strategy.

Moreover, the results showed no interaction between the three emotion regulation strategies. However, the effect size of fixed factors in the interaction models were higher than the main effect model in both outcome variables (self-report: $R^2_{interaction}$ = 0.588, R^2_{main} = 0.576; sum of amplitudes: $R^2_{interaction}$ = 0.052, R^2_{main} = 0.056)

Therefore, the third hypothesis (i.e., in fatigue condition, distraction decreases negative feelings more than affect labeling and reappraisal, respectively) **was not supported.**

Effects of Cognitive Fatigue on Emotion Regulation Strategies

In contrast to Grillon et al. (2015), the results did not indicate that the effectiveness of emotion regulation strategies were depended on cognitive fatigue. The results did not even show the main effect of cognitive fatigue. While the simplest explanation would be that the mental calculation failed to induce the desired effect, participants still reported that they perceived the fatigue condition to be more difficult than the non-fatigue condition. It is possible that although the mental calculation, a common paradigm used to induce cognitive fatigue, might be cognitive demanding for the participants, they were not cognitively depleted to the point that would hinder their emotion regulation performance. When completing the unfamiliar emotion regulation tasks, the participant might still be able to tap into their cognitive reserves to compensate for fatigue from the mental calculation. The other possibility could be that participants were cognitively fatigued in both condition and the 10-minute break were not enough for a recovery. In the latter explanation, it could mean that the effectiveness of each strategy was less dependent on the available cognitive resources as the author originally thought; and that the reappraisal strategy was robust even in the face of cognitive constraints. However, the other explanation of this outcome is that the mental calculation might not access the same resources as cognitive control of emotion. Cognitive controls involved three different executive processes including switching, updating, and inhibition (Miyake & Friedman, 2012). To date, research on the link between emotion regulation and the cognitive controls have reported conflicting results, for example, McRae et al. (2012) found that reappraisal is correlated with working memory and switching abilities but not inhibition. Whereas, Gyurak et al. (2012) found that verbal fluency was linked to an ability to suppress emotional response, but not inhibition and working memory. Thus, the mental calculation task which requires an updating working memory, might not influence the participants' emotion regulation ability in this study.

Effects of Emotion Regulation Strategies on Negative Emotions

The current research also investigated the effectiveness of three emotion regulation strategies: cognitive reappraisal, attentional distraction, and affect labeling. Results have shown that, regardless of the cognitive fatigue conditions, all three strategies were more effective in reducing the self-report intensity of negative emotions than the negative baseline-control, where the participants were not explicitly told to use any regulation strategy. These findings were in line with previous studies which compared the effectiveness of reappraisal and distraction (Bettis et al., 2018; Kross & Ayduk, 2008; McRae et al., 2008; Sheppes & Meiran, 2007; Strauss et al., 2016), as well as, reappraisal and affect labeling (Lieberman et al., 2011) against a control condition.

Moreover, among the three strategies, cognitive reappraisal was shown to be consistently more effective than distraction and affect labeling in the self-report measure. However, in the skin conductance measure, reappraisal and distraction did not significantly differ and, at the same time, both were more effective than affect labeling. It is possible that while both reappraisal and distraction strategies were similarly successful at diminishing negative emotions at the physiological level, the participants might not be fully aware of such effect. By contrast, affect labeling seemed to be the least effective among the three strategies, especially in the self-report negative emotions. Lieberman et al. (2011) suggest that individuals may not believe that labeling their emotions is useful for decreasing negative feelings. Such bias could play a role in self-report measures. Nonetheless, the physiological measure showed a similar trend to the self-report measure, suggesting that affect labelling was not on a par with cognitive reappraisal in terms of reducing negative emotions.

The effectiveness of affect labeling might be contingent upon other circumstances, such as repeated usage of the strategy. Kircanski et al. (2012) demonstrated that when individuals applied affect labeling to a fearful stimulus for the second time, they showed a decrease in skin conductance response. Furthermore, some individuals might be better at employing affect labeling than others, for example, Barrett et al. (2007) suggested that people who have high emotional granularity: an ability to distinguish emotional states at high level, are better at understanding their emotional states. Since affect labeling relies on awareness of internal emotional states, therefore, individuals who are better at identifying the specifics of their emotions and/or be able to understand their emotions could benefit more from this strategies (Torre & Lieberman, 2018).

The Relationship between Self-Report Negative Emotions and Physiological Measure

The sum of SCR phasic amplitudes, which represented the magnitude of emotional arousal, was found to be unexpectedly low in the negative baseline-control tasks. Several possibilities exist. Stronger physiological responses in emotion regulation conditions than those in the baseline-control could be explained with the carry-over effect as the baseline-control always appeared at the beginning of the experiment. Schwartz and Andrasik (2017) suggested that temporal factor might cause participants to become physically fatigue. Such effect could interfere with physiological measurement over time. Skin conductance measure is sensitive to very subtle changes in human's body and can capture what may be beyond participant's consciousness (Larsen et al., 2008). However, the additional analysis of times that the participants implemented emotion regulation strategies did not show a strong effect. Therefore, the other explanation for this result could be that in the experimental conditions, the participants were more aware of their emotions than in the negative baseline-control. Research has shown that some emotion regulation strategy efficiency are associated with high emotional awareness, (e.g., reappriasal in Eastabrook et al., 2014; affect labeling in Barrette et al., 2007). Sze et al. (2010) also found that high level of bodily emotional awareness is associated with subjective emotional experience. Therefore, when participants were requested to perform such strategies, their emotional awareness might arise. As such, their physical reactions also emerge simultaneously. However, this explanation could not account for the fact that self-report negative emotions in the negative baseline-control was higher than the experimental conditions. The implicit-explicit distinction seems more probable in this case. Commonly, explicit emotion regulation involves an explicit goals and controlled change process, while implicit emotion regulation involves more autonomic change processes with implicit goals (for a review, see Braunstein et al., 2017). These two dual-processes paradigms could explain a degree to which participants' self-reports emotions were higher than the sum of SCR amplitudes in the baseline-control group. Typically, individuals had their own way to regulate emotion if they were not instructed to do any specific regulations. Research has suggested that even without explicit instruction, people reported that they used emotion regulation fairly regularly on a daily basis (Grillon et al., 2015; Gyurak et al., 2011). This so called “habitual emotion regulation” can be initiated quickly and effortlessly as an implicit response to emotional stimuli. This suggestion was in line with Webb and colleagues’ (Webb et al., 2012) meta-analysis which revealed that sometimes a control condition (i.e., participants were given no instruction) had a larger effect than emotion regulation conditions due to the fact that, when given no explicit instructions, participants might cope with negative emotions in their usual manner. Nonetheless, this implicit process might occur automatically outside participants’ awareness. As a result, they might not show a decrease in self-report negative emotions, though they physiological responses had already been regulated.

Limitations and Suggestions for Future Research

A number of methodological issues could limit the conclusions. First, an absence of the fatigue effect illustrated the limitation of the mental calculation as a cognitive fatigue task. On one hand, the task might not be demanding enough, and a stronger fatiguing task is required. On the other, the tasks in both conditions might already be demanding and the 10-minute rest was not enough for a recovery. While this current research implemented the difficulty task rating to check for a demand level, the study could benefit from a more direct measure of cognitive fatigue, which would also allow us to compare the effect with other studies.

Second, the majority of samples of this study were university students who differ in some ways from the population in the same age range (18-30 years old). The difference in an ability to access one's own thought and background knowledge could impact how one would redirect thoughts and construct a reasonable ones to deal with negative emotions (e.g., "snakes play an important role in our ecosystem by maintaining a balance to the food web."). Future studies could include a wider range of participants.

Third, the choice between self-report negative emotion and physiological measures could impact how researchers interpret their findings. As illustrated in our study, relying on either measurement could lead to a different conclusion when comparing the experimental conditions with the baseline-control. The author encourages researchers to employ both type of measurements when feasible.

Conclusions

Emotion regulation is a fundamental ability to adapt individual's behavior to different situations. Different emotion regulation strategies have been explored in many domains such as clinical, psychology mental health, neuroscience, etc. The present study provided a consistent conclusion with previous works which showed that reappraisal worked better than distraction and affect labeling. On the other hand, the results did not demonstrate any difference in emotional responses when comparing the cognitive fatigue conditions, suggesting that these all three strategies may very sensitive to the decrease cognitive resources. Additionally, an ability to access one’ own thought and emotion may play a key role in explaining the discrepancy between self-report and physiological measures of emotion.

Chapter 5

Summary

Objectives of the Research

1) To compare directly the effectiveness of three emotion regulation strategies including reappraisal, distraction, and affect labeling.

2) To examine the effect of cognitive fatigue to each emotion regulation strategy.

3) To compare directly the effectiveness of three emotion regulation strategies including reappraisal, distraction, and affect labeling under cognitive fatigue.

Hypotheses

Hypothesis 1: In non-fatigue condition, reappraisal will decrease negative feelings more than distraction and affect labeling, respectively.

Hypothesis 2: Cognitive fatigue will generally dampen the effectiveness of all emotion regulation strategies, however, cognitive fatigue will differently diminish the effectiveness of each strategy.

Hypothesis 3: In fatigue condition, distraction decreases negative feelings more than affect labeling and reappraisal, respectively.

Samples

Forty-nine individuals (M_{age} = 22.4; 41 female) were recruited through classes (e.g., General Psychology) and social network.

Materials

Forty pictures selected from International Affective Pictures (IAPs) with valence of pictures are between 3.5 to 5 for neutral pictures and 1 to 3.5 for negative pictures. The arousal of pictures is between 1 to 3 for neutral pictures and 4.3 to 7 for negative pictures.

Measures

Physiological activity

Skin Conductance Response (SCR) was utilized as the physiological measure of negative emotional arousal. SCR was recorded by The ProComp infiniti: Electrodermal Activity device (EDA) device from Thought Technology Inc. Skin conductance signals are transmitted using two electrodes attached to the ring and middle fingers of the non-dominant hand. The raw EDA signal provides two distinct sets of data: Skin Conductance Level (SCL) and Skin Conductance Response (SCR). In this research, the sum of amplitudes from the analysis of phasic skin conductance response was used as an outcome variable.

Self-reported Negative Emotions

Negative emotions was assessed by the subjective intensity of emotions. A rating scale question, read “ความรู้สึกของคุณมีความเข้มข้นเพียงใด” (transl. “how intense was your feeling?”), was used to assess the participant's negative emotional experience (1 = ไม่รู้สึกอารมณ์ทางลบเลย [transl. *did not feel any negative emotion at all*] to 7 = รู้สึกอารมณ์ทางลบอย่างมากที่สุด [transl. *strongly felt negative emotions*]). The item was presented following each IAPS picture.

Self-reported Difficulty of Tasks

The difficulty of tasks was used for the manipulation check and was assessed by a rating scale question “คุณคิดว่างานที่ทำมีความยากเพียงใด” (transl. “how difficult was the task?”) ranging from 1 (ไม่มีความยากเลย [transl. *the task was not difficult at all*] to 7 (มีความยากอย่างมากที่สุด [transl. The task was strongly difficult]) following cognitive fatigue task.

Procedure

Forty-nine participants were randomly assigned into one of the fatigue conditions (fatigue vs. non fatigue) by incomplete block design method. Then, completed the emotion regulation tasks (i.e., reappraisal, distraction, and affect labeling) in a random order. They were given time to rest for 10 minutes between each fatigue task. In 10 minutes later, the participants completed the other fatigue condition, followed by emotion regulation tasks.

Shortly after participants arrived in the laboratory, they were asked to read and sign an informed consent and complete the checklists. After that, they were asked to sit in front of a laboratory computer. After that, the experimenter attached the skin conductance electrodes to the distal phalanges of the first and middle finger of a participant's non-dominant hand. Participants, then, attended a cognitive fatigue session for 10 minutes. As soon as they finished the tasks, the participants were asked to complete the difficulty of the task question. This was followed by emotion regulation training sessions. Subsequently, participants were directly presented to an instruction video clip strategy of which they were assigned to. Then, they were informed to perform emotional regulation tasks when the pictorial stimuli appeared. Pictures were presented randomly and lasted 30 seconds for each. After seeing each picture, participants were asked to rate the intensity of emotions. After all the emotion regulation tasks was done, the experimenter removed electrodes from the participant's hand. Participants were asked manipulation check questions and were debriefed at the end of experiments. Finally, all participants received money for 200 Baht and thanked for the participation.

Data Analysis

All statistical analyses were performed using the open-source language R 3.6 (R development Core Team, 2019). Linear mixed-effect modeling (Bates, 2005), performing by lme4 package (Bates et al., 2015), was used in order to test the effect of each emotion regulation strategies and fatigue conditions. Furthermore, MuMin package (Barton, 2020) was used to calculate overall variances of the statistical models.

Results

1) There are significant differences in all three emotion regulation strategies when compared to a control condition.

2) Reappraisal is the most effective strategies compared to distraction and affect labeling, respectively.

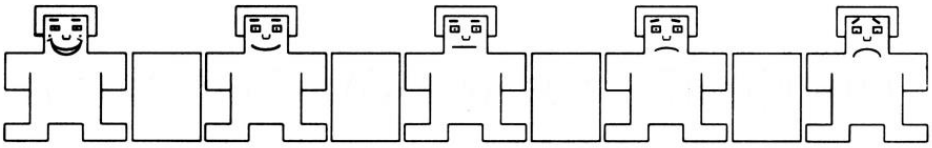
3) There is no significant difference between cognitive fatigue and non-fatigue condition.

Future Research Suggestions

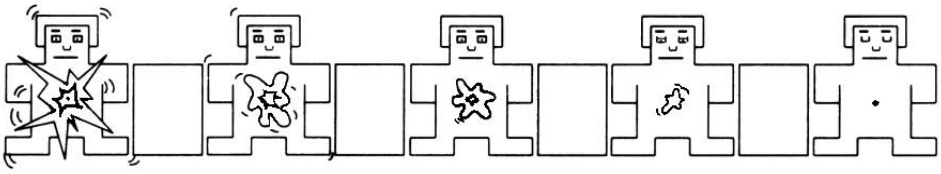
Emotion regulation has been explored in multiple disciplines. Research have compared the effectiveness of emotion regulation strategies under different settings. However, apart from the strategies that has been studied in this current research, there are many more emotion regulation strategies such as emotion suppression, mindfulness, expressive writing, etc. Therefore, the author suggests that future investigations may examine the effect of cognitive fatigue to other emotion regulation strategies, as well as, the relationship between implicit – explicit emotion regulations that could play an important role to the outcome of cognitive constraints.

Appendix A

The Self-Assessment Manakin (valence and arousal; Bradley, & Lang, 1994)



Valence



Arousal

Samples of International Affective Picture System

(Lang, Bradley & Cuthbert, 2005)

Neutral pictures

Negative pictures

Appendix B

1. แบบสอบถามข้อมูลส่วนบุคคล

<u>คำชี้แจง</u> ทำเครื่องหมาย √ ในช่อง ( ) หน้าข้อความที่ตรงกับตัวเองมากที่สุดและเขียนรายละเอียดเกี่ยวกับตัวท่านในช่องว่าง

ข้อมูลส่วนบุคคล

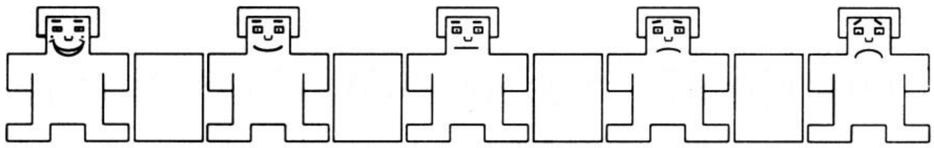
1. เพศ ( ) ชาย ( ) หญิง ( ) อื่น ๆ
2. อายุ .... ปี
3. ในช่วง 24 ชั่วโมงที่ผ่านมา ท่านดื่มแอลกอฮอล์หรือไม่
   a. ดื่ม ( ) ไม่ได้ดื่ม ( )
4. ในช่วง 3 ชั่วโมงที่ผ่านมา ท่านได้ดื่มเครื่องดื่มที่มีคาเฟอีนหรือไม่
   a. ดื่ม ( ) ไม่ได้ดื่ม ( )

2. แบบประเมินชุดภาพ

แบบประเมินชุดภาพ (ตัวอย่าง)

คำชี้แจง หลังจากท่านได้ชมภาพแล้ว ให้ท่านประเมินแต่ละภาพใน 2 มิติ มิติแรกคือความน่าพึงพอใจของภาพ และมิติที่สองคือความเร้าอารมณ์ของภาพ

โดยให้ทำเครื่องหมาย ○ ล้อมรอบระดับความรู้สึกที่ตรงกับตัวท่านมากที่สุด

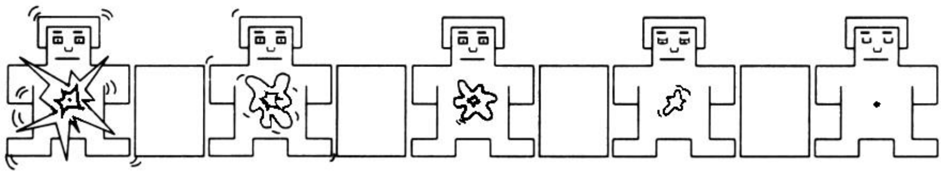


มิติด้านความน่าพึงพอใจ

มากที่สุด **น้อยที่สุด**

7 6 5 4 3 2 1

มิติด้านกระตุ้นเร้าอารมณ์



มากที่สุด **น้อยที่สุด**

7 6 5 4 3 2 1

Appendix C

Instructions for emotion regulation condition in Thai language

Reappraisal condition: “ความคิดและความรู้สึกเป็นสิ่งที่มีความสัมพันธ์กัน หากท่านเปลี่ยนความคิด ความรู้สึกก็จะมีแนวโน้มที่จะเปลี่ยนตามด้วย ในการทดลองนี้ พยายามเปลี่ยนความรู้สึกของท่านทีมีต่อภาพโดยการเปลี่ยนความคิด เช่น ท่านอาจรู้สึกกลัวงูที่อยู่ในภาพ แต่หากท่านนึกถึงประโยชน์ที่งูช่วยกินหนูอาจทำให้ความรู้สึกท่านเปลี่ยนไปได้ หรือท่านอาจคิดว่าภาพงูเป็นเพียงภาพไม่ได้มีอิทธิพลต่อท่านในตอนนี้”

Distraction condition: “การนึกถึงสิ่งอื่นที่ไม่เกี่ยวข้องกับสิ่งที่จะทำให้ท่านเกิดอารมณ์จะช่วยให้ท่านประสบกับอารมณ์ทางลบน้อยลงได้ ในการทดลองนี้ พยายามนึกถึงเหตุการณ์ที่ทำให้ท่านมีความสุข เช่น ท่านอาจเห็นภาพงู แต่ให้พยายามนึกถึงเหตุการณ์ที่ท่านดีใจอย่างมาก เช่น การสอบติดมหาวิทยาลัย หรืออาจนึกถึงสิ่งที่ท่านชอบ เช่น เพลง ภาพยนตร์ หรืออาหารจานโปรด”

Affect labeling condition: “การตระหนักรู้ถึงอารมณ์ที่ท่านกำลังมีอยู่อาจมีแนวโน้มทำให้ท่านประสบกับอารมณ์ทางลบน้อยลง ในการทดลองนี้ พยายามนึกถึงชื่อของความรู้สึกของท่านเมื่อเห็นภาพนี้ หากอารมณ์นั้นมีความซับซ้อน เช่น ท่านประสบกับอารมณ์กลัวและขยะแขยงไปพร้อม ๆ กัน ให้ท่านเลือกอารมณ์ที่มีความเด่นชัดที่สุด”

Appendix D

Sample pictures of EDA device and EDA attached to a subject's hand

EDA device

ProComp Infiniti Device

Appendix E

Sample of Randomization of the Incomplete Block Design with Non-Circular Permutation

	Order			
Block	1	2	3	4
1	F-R	F-D	F-L	N-R
2	F-R	N-R	N-D	N-L
3	F-D	F-L	N-D	N-L
4	F-R	F-D	F-L	N-D
5	F-R	F-D	N-R	N-L
6	F-L	N-R	N-D	N-L
7	F-R	F-D	F-L	N-L
8	F-R	F-L	N-R	N-D
9	F-D	N-R	N-D	N-L
10	F-R	F-D	N-R	N-D
11	F-R	F-L	N-D	N-L
12	F-D	F-L	N-R	N-L
13	F-R	F-D	N-D	N-L
14	F-R	F-L	N-R	N-L
15	F-D	F-L	N-R	N-D

* *Note*. The acronyms represent the condition

F - Fatigue condition,

N – Non-fatigue condition,

R – Reappriasal,

D – Distraction,

L – Affect Labeling

Appendix F

Results of the addition analysis testing the carry-over effect of times in the Sum of Amplitudes variable.

	Sum of Amplitudes		
Predictors[a]	*Estimates*	*SE*	*t*
(Intercept)	-0.74	0.03	-19.91***
Times	0.01	0.01	0.87
Condition [non-fatigue]	-0.01	0.42	-0.3
Distraction	0.03	0.04	0.83
Labeling	0.09	0.04	2.22*
Non-fatigue * Distraction	0.01	0.06	0.26
Non-fatigue * Labeling	-0.01	0.06	-0.25
Random Effects			
σ^2	0.02		
$\tau_{00\ id}$	0.00		
Marginal R^2 / Conditional R^2	0.053 / 0.053		

Note. * = *p* < 0.05, ** = *p* < 0.01, *** = *p* < 0.001

[a] Fatigue condition and reappraisal were coded as reference conditions

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