Personality and Social Psychology Review
XX(X) 1–13

DOI: 10.1177/1088868310395778
http://pspr.sagepub.com
SAGE

Is Timing Everything? Temporal Considerations in Emotion Regulation

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Abstract

It is often said that timing is everything. The process model of emotion regulation has taken this aphorism to heart, suggesting that down-regulating emotions before they are "up and running" is always easier than down-regulating emotions once they have gathered force (i.e., *generic timing hypothesis*). But does timing (i.e., emotion intensity) matter equally for all forms of regulation? In this article, the authors offer an alternative *process-specific timing hypothesis*, in which emotion-generative and emotion-regulatory processes compete at either earlier or later stages of information processing. Regulation strategies that target early processing stages require minimal effort. Therefore, their efficacy should be relatively unaffected by emotion intensity. By contrast, regulation strategies that target later processing stages require effort that is proportional to the intensity of the emotional response. Therefore, their efficacy should be determined by the relative strength of regulatory versus emotional processes. Implications of this revised conception are considered.

Keywords

emotion, emotion regulation, process model, reappraisal, distraction, information processing

Which situation would be harder to manage: starting to control your emotions early in an upsetting situation before you were upset, or starting to control your emotions once you were already upset? At first glance, the answer seems obvious. Whatever you might wish to do to down-regulate your emotions, early intervention would seem to be more effective than late intervention. We refer to this idea as the *generic timing hypothesis.*

In the domain of affective science, the generic timing hypothesis is reflected in one of the dominant theoretical accounts of emotion regulation—the process model of emotion regulation (for reviews, see Gross, 1998a, 2001; Gross & Thompson, 2007). But is the generic timing hypothesis correct? Are all forms of emotion regulation more easily and effectively executed at lower rather than at higher levels of emotional intensity?

In what follows, we first describe the generic timing hypothesis as it is instantiated in the process model of emotion regulation and review indirect evidence that supports this hypothesis. We then introduce the *process-specific timing hypothesis*, which suggests that different forms of emotion regulation should be differentially sensitive to the intensity an emotional response has reached prior to the initiation of regulation because different regulation strategies modulate the emotional response at different cognitive processing stages. Next, we provide new evidence from direct tests of the process-specific timing hypothesis. These findings show that regulation strategies that target an early selection processing stage are relatively uninfluenced by the intensity of the emotion that is being regulated. By contrast, strategies that target a late selection processing stage generally become less effective as the emotion that is being regulated becomes stronger, although the relative strength of late selection strategies can moderate the impact of high levels of emotional intensity. We conclude by considering several new directions for research in the areas of development, decision making, and clinical psychology.

Emotion Regulation and the Generic Timing Hypothesis

The process model of emotion regulation (Gross, 1998a) is predicated on the idea that emotions develop and gain strength over time (see Level A of Figure 1). Specifically, an emotion is thought to come into being and increase in intensity through a recursive situation–attention–appraisal–response sequence in which an individual encounters a particular type of situation (actual or imagined), attends to this situation in particular ways, and then interprets the situation in a way that gives rise to a loosely coordinated pattern of changes in experiential, behavioral, and physiological

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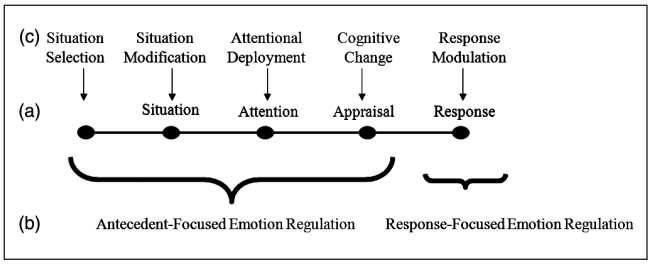

Figure 1. The process model of emotion regulation (adapted from Gross & Thompson, 2007)
(a) Components of emotion generation. (b) Antecedent-focused versus response-focused emotion regulation strategies. (c) Five emotion regulation families.

response systems (Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005).

In the process model, the temporal progression from one stage to the next in a given iteration (e.g., from situation to attention), or from one iteration to the next (e.g., moving from the first situation–attention–appraisal–response iteration to the second one), represents the way that the emotion-generative process gathers strength and develops in intensity. Emotional intensity can range from a zero point where there is no indication of an emotion to a maximum degree that varies for different emotion types, situations, and contexts (Reisenzein, 1994). For present purposes, intensity is best understood as the magnitude of activation in the coordinated response systems that constitute emotion. Therefore, a core feature of the process model is the idea that in many contexts, timing may be used as a proxy for emotional intensity. In our process-specific framework, which is elaborated below, we also treat timing as a proxy for emotional intensity, but we develop this logic further and consider complications and alternatives.

According to the process model of emotion regulation, different families of emotion-regulatory processes may be distinguished according to when in the emotion-generative process they have their primary impact. At the broadest level, this model distinguishes between *antecedent-focused strategies* that start operating early in a given iteration of the emotion-generative process, before response tendencies are fully activated, and *response-focused strategies* that start operating later on, after emotion response tendencies are more fully activated (see Level B in Figure 1). Within these broad categories, specific families of emotion regulation processes are postulated to map onto each of the specific steps in the emotion-generative process (see Level C in Figure 1).

The emphasis placed on the developing emotional response signals the importance that this conception of emotion generation and emotion regulation places on the generic timing hypothesis. In this context, a major feature of the generic timing hypothesis is that antecedent-focused strategies are thought to be generally more effective than response-focused strategies. This is because antecedent-response-focused strategies divert the emotional trajectory quite early, before emotional response tendencies are fully developed, whereas response-focused strategies must overcome a well-developed suite of interrelated emotion processes (e.g., Gross, 2001).

To date, one of the main ways that the generic timing hypothesis has been tested is by pitting *cognitive reappraisal*, which is an antecedent-focused strategy that involves construing an emotional situation in nonemotional terms, against *expressive suppression,* which is a response-focused strategy that involves inhibiting emotion-expressive behavior. The basic logic of this comparison is that reappraisal (which alters the emotional trajectory early on) should be a more effective regulation strategy than suppression (which intervenes later, and thus has to combat a higher intensity emotional response).

Results from a large number of studies have demonstrated the relative costs of suppression relative to reappraisal in affective, cognitive, and social domains. Affectively, suppression but not reappraisal leaves negative emotional experience unchanged (see Gross, 2002, for a review), increases sympathetic nervous system activation (e.g., Gross, 1998a; Gross & Levenson, 1993, 1997), and increases activation in emotion-generative brain regions (Goldin, McRae, Ramel, & Gross, 2008). Cognitively, suppression but not reappraisal results in poorer memory for the emotion-eliciting situation, possibly because of the resource depletion associated with higher levels of cognitive effort (see Richards, 2004, for a review). Socially, individuals interacting with people who are engaging in suppression but not reappraisal show increased physiological responses that may reflect the effects of communicating with a nonresponsive partner (Butler et al., 2003).

In more recent studies, differences between antecedent-focused reappraisal and response-focused suppression have been extended to other important domains. For example, in decision making, reappraisal but not suppression efficiently reduces the experience of fear and disgust, which results in lower levels of emotion-related biases such as loss aversion (Heilman, Crişan, Houser, Miclea, & Miu, 2010). In the emotional eating domain, regulating negative mood with suppression but not reappraisal leads to increased food intake of high caloric foods (Evers, Stok, & de Ridder, 2010). In an academic setting, suppression contributes to working memory deficits that cause academic performance decrements that are related to stereotype threat, and reappraisal eliminates these negative consequences (Johns, Inzlicht, & Schmader, 2008).

These findings provide compelling evidence that reappraisal and suppression have different affective, cognitive, and social consequences. These findings also provide initial evidence in support of the generic timing hypothesis. However, the evidence in favor of the generic timing hypothesis is indirect rather than direct.

One way in which the evidence is indirect is that, although reappraisal and suppression are hypothesized to differ with

respect to when they have their primary impact on the emotion-generative process, they differ in many other ways as well. For example, reappraisal is a cognitive form of emotion regulation, whereas suppression is a behavioral form of emotion regulation. These two strategies also differ in their targets (see Level C in Figure 1): Reappraisal induces cognitive change and tries to modify the emotional appraisal, and suppression induces response modulation and targets the behavioral emotional response system. A second way in which evidence is indirect is that timing differences between reappraisal and suppression are theoretically assumed by the model but not directly manipulated. That is, reappraisal and suppression are assumed to operate before and after response tendencies are fully activated, respectively, but the level of emotional intensity prior to initiating these strategies is not directly manipulated. Thus, although differences between reappraisal and suppression are important in their own right, they do not provide a strong test of the process model's generic timing hypothesis.

Toward a More Direct Test of the Generic Timing Hypothesis

Instead of studying different emotion regulation strategies that diverge in several ways (e.g., contrasting reappraisal and suppression) and making assumptions about their likely temporal profiles, a more direct test of the timing hypothesis would be possible if one could directly manipulate the timing of a single regulation strategy. In this way, it would be possible to isolate the relevant timing factor and hold all other factors constant. For example, one might examine the effects of reappraisal when it is initiated under low versus high levels of emotional intensities (i.e., early vs. late in an unfolding emotional response).

One potential barrier to this approach is the view that any emotion regulation process can operate only at one given point in the emotion-generative process. For example, if reappraisal is conceived of as "antecedent focused," it might be thought that it can only operate *before* emotional response tendencies develop and at no other time point. Likewise, if suppression is conceived of as "response focused," it might be thought that it can operate only *after* emotional response tendencies develop and at no other time point. If this were true, a direct test of the timing hypothesis would be precluded.

However, according to the process model, emotion generation is a dynamic process that involves repeated cycles through the emotion-generative process (see, e.g., Gross & Thompson, 2007, pp. 16-17). If emotions arise and increase in intensity as a result of multiple cycles through the emotion-generative process, it should be possible to engage in emotion regulation at various points as an emotion episode unfolds over time. That is, reappraisal (or any other strategy) may be engaged either under low levels of emotional intensity, in one of the first few emotion-generative cycles, or under high levels in emotional intensity, in one of the later emotion-generative cycles.

Nevertheless, directly assessing the generic timing hypothesis requires a shift in the type of question asked. Previous investigations (Gross & Thompson, 2007) have generally focused on the effects of antecedent- versus response-focused strategies that were implemented during the first emotion-generative cycle (see Figure 2a, 2b). That is, participants were instructed prior to an emotional event how to regulate their emotions. The idea here was that different regulation strategies that are implemented in the first iteration would lead to different effects on the emotional response in subsequent iterations. Reappraisal that is implemented in the first iteration reduces emotional intensity in subsequent iterations (see Figure 2a). By contrast, suppression that is implemented in the first iteration results in no change or an increase in emotional intensity that continues to develop in subsequent iterations (see Figure 2b). Note that in these studies, the initial emotional intensity, prior to the implementation of emotion regulation, is fixed and minimal as these strategies are implemented as soon as the emotional event begins.

Directly assessing the generic timing hypothesis requires concentrating on regulatory strategies that are initiated during different emotion-generative cycles (see Figure 3a, 3b). That is, the effectiveness of one or more regulation strategies (e.g., distraction or reappraisal) needs to be evaluated when strategies are initiated under different levels of emotional intensity. Directly testing each of several different emotion regulation strategies at varying temporal phases of an emotional event makes it possible to ask whether all forms of emotion regulation work better under low relative to high levels of emotional intensity. What might we expect from such a test?

One possibility—suggested by the generic timing hypothesis—is that no matter which form of regulation we examined, we would always find that emotion regulation is more effective when initiated when emotion was at low levels of intensity than when emotion was at high levels. A second possibility, suggested by the *process-specific timing hypothesis*, is that time matters a great deal for some forms of emotion regulation and little or not at all for other forms of emotion regulation.

The basic logic of the process-specific timing hypothesis derives from a consideration of when and how emotion-generative processes are altered via emotion-regulatory processes. Our account borrows heavily from information processing theories, which argue that people have limited cognitive capacity to execute mental operations (e.g., Pashler, 1998). The constraints posed by limited capacity and cognitive resources dictate a continuous competition between different sources of information for dominance and consequently for determining the final output or response of the cognitive system.

This competition among different sources of information occurs at two major processing stages (e.g., Hubner, Steinhauser,

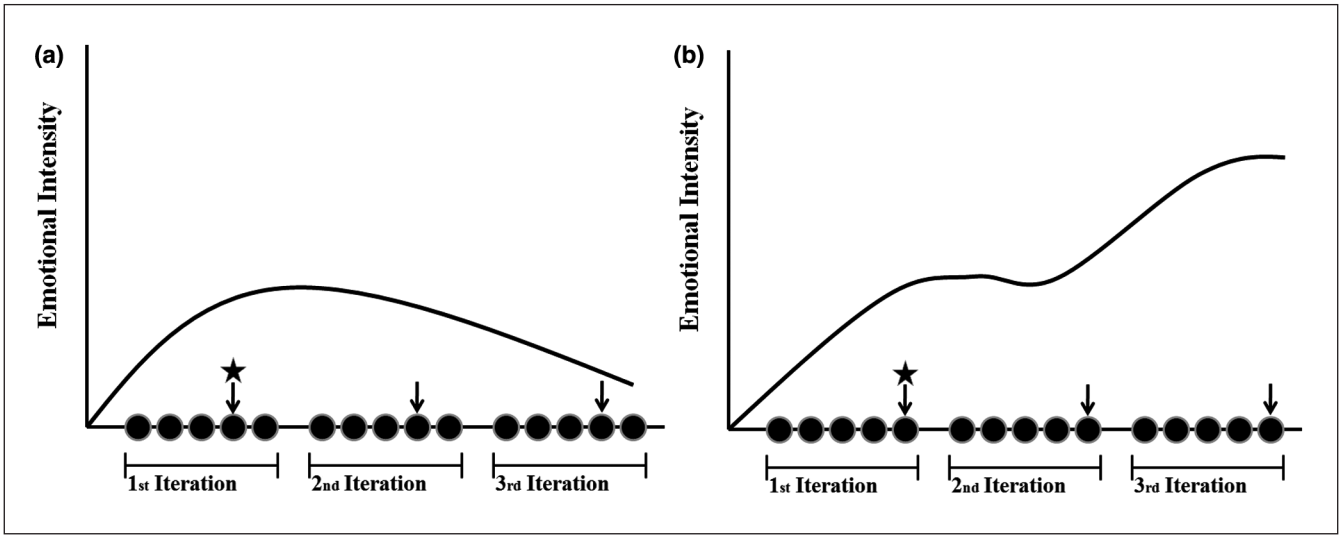

Figure 2. Antecedent- and response-focused regulation across three iterations of the emotion-generative cycle (adapted from Urry, 2009)
The star represents the point of strategy implementation. Arrows represent the process that is being targeted by the regulation strategy in each iteration. (a) Operation of antecedent-focused reappraisal (a type of cognitive change). Reappraisal that begins at the appraisal stage of the first iteration successfully modulates a low emotional intensity response. The effect of this successful regulation by reappraisal can be seen in the drop of emotional intensity by the third iteration. (b) Operation of response-focused suppression (a type of response modulation). Suppression that begins in the response stage of the first iteration does not successfully modulate the intensity of the emotional response, which continues to accumulate in subsequent iterations.

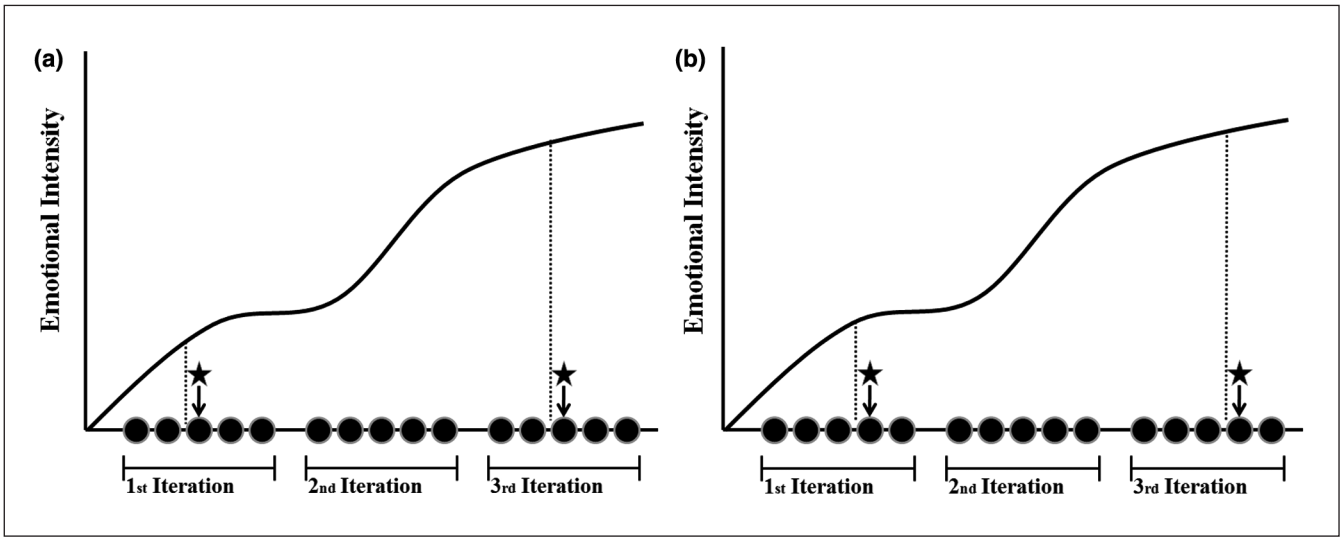

Figure 3. Directly testing the generic timing hypothesis (adapted from Urry, 2009)
The star represents the point of strategy implementation. The dotted line represents the level of emotional intensity immediately prior to strategy implementation. (a) Demonstrates the comparison of distraction (a type of attentional deployment) when it is initiated under low levels of emotional intensity (Cycle 1) relative to high levels of emotional intensity (Cycle 3). (b) Demonstrates the comparison of reappraisal (a type of cognitive change) when it is initiated under low levels of emotional intensity (Cycle 1) relative to high levels of emotional intensity (Cycle 3).

& Lehle, 2010; Johnston & Heinz, 1978; Pashler, 1998). At the early stage, incoming perceptual information competes to capture selective attention, and a filtering mechanism determines which stimuli gain access to the next stage, where more elaborated semantic analysis occurs. Resolution of conflict via the early filtering mechanism requires minimal resources. At the late stage, different types of representations compete at the semantic level to affect the final response. Resolution of conflict at this stage requires more mental effort because more information is gathered about the nature

of the stimuli in question (Johnston & Heinz, 1978). However, this account also suggests that the effort associated with late stage regulation might be reduced for tasks that become habitual (Pashler, 1988).

How might these considerations apply to emotion regulation? We propose that emotion-generative and emotion-regulatory processes can compete at both early and late processing stages and that the later the emotion-regulatory process occurs, the more likely it is to be affected by the level of emotional intensity. Emotion regulation strategies that operate at an early stage (*early selection strategies*) should be relatively unaffected by the level of emotional intensity because they replace existing and incoming emotional information with minimal effort. By contrast, emotion regulation strategies that operate at a late stage (*late selection strategies*) should be affected by the level of emotional intensity because they require effort to modify existing and incoming emotional information.

Contrasting (Early Selection) Distraction and (Late Selection) Reappraisal Under Low and High Emotion Intensities

Motivated by these theoretical considerations, we evaluated the process-specific timing hypothesis through a series of studies in which we contrasted early versus late selection emotion regulation strategies under low versus high levels of emotional intensity.

The early selection strategy that was chosen was *distraction*, which involves diverting attention away from an emotional situation by loading working memory with independent neutral contents (see Van Dillen & Koole, 2007). In distraction, the neutral contents that are called to mind are independent from, and not in conflict with, the emotional contents (e.g., thinking about errands in the presence of a distressing situation). Therefore, distraction involves replacing existing emotional information with independent neutral information. Furthermore, incoming emotional information competes with emotion-regulatory processes at an early processing stage before stimuli are represented in working memory for further semantic evaluative processing. That is, distraction prevents the affective meaning of a stimulus from being processed by blocking it via a strong early selection filter.

The late selection strategy that was chosen was *cognitive reappraisal*, which entails attending to the emotional stimulus and reinterpreting the meaning of this stimulus in a way that alters its emotional impact (e.g., Gross, 1998b). In reappraisal, the basic emotional representation functions as the building block of the neutral reinterpretation. Therefore, the reinterpreted neutral representation is, by definition, associatively linked to the emotional representation (e.g., the process of reinterpreting a distressing situation requires directly relating to the distressing situation). Consequently, in reappraisal, existing and incoming emotional information is modified via a dependent neutral reinterpretation, and a semantic conflict exists between the emotion-generative and emotion-regulatory representations. That is, in reappraisal, emotional information passes the early attentional stage and is provided elaborated semantic meaning before it is modified via a weak late selection filter that requires increased cognitive resources to operate (also see Kalisch, Wiech, Herrmann, & Dolan, 2006, for a related categorization of distraction and reappraisal).

It bears noting that although Gross's (1998a) process model makes an important conceptual distinction between distraction (which occurs at Stage 3—attentional deployment) and reappraisal (which occurs at Stage 4—cognitive change), with regard to the generic timing hypothesis, both of these strategies are considered antecedent-focused strategies, and thus the emphasis is on commonalities rather than differences. Therefore, our present investigation could be framed as making further distinctions within the antecedent-focused regulation category among strategies that differ in their processing operation. In addition to their theoretical importance, reappraisal and distraction are considered major and effective cognitive emotion regulation strategies (e.g., McRae, Hughes, Chopra, Gabrieli, Gross, & Ochsner, 2010; Ochsner & Gross, 2005). Thus, these strategies are ideal candidates for studying their effectiveness at differing points in the emotion-generative process (i.e., under differing emotional intensities).[1]

The process-specific timing hypothesis leads to clear predictions regarding how early versus late selection strategies should be affected by emotional intensity. For early selection distraction, resolution of conflict via the early filtering mechanism requires minimal resources, and the neutral contents that are formed are semantically independent from the emotional contents. Distraction thus should be able to overcome low and high levels of emotional intensity successfully by replacing existing emotional information with independent neutral information and by blocking incoming emotional processing via a strong early filtering mechanism. This is not to say that distraction would entirely block all levels of emotional intensity; however, we predict that the underlying mechanisms in distraction can successfully block relatively high levels of emotional intensities.

By contrast, for late selection reappraisal, resolution of conflict between the emotion processing and the regulatory neutral reinterpretation via the late semantic analysis filter requires cognitive resources. Specifically, it becomes hard to modify high intensity levels of existing and incoming emotional information with a dependent neutral reinterpretation via a weak late filtering mechanism. Therefore, reappraisal should be less able to modulate high than low levels of emotional intensity. This means that in reappraisal, the effort and consequential success of the monitoring process in modulating the emotional response depend on the relative intensity of the emotional response that is being overridden (e.g., Hoeksma,

Oosterlaan, & Schipper, 2004). Therefore, the process-specific timing hypothesis leads to the prediction that for reappraisal, high emotional intensity should be more difficult to override than low intensity, although factors that strengthen the process of reappraisal should moderate the effect of high emotional intensity. For example, as is demonstrated below, a prolonged monitoring effort may eventually be able to overcome high levels of emotional intensity.

In the studies described below, the elapsed time prior to the implementation of a regulation strategy was used as a manipulation of emotional intensity. Operationally, this has been achieved by instructing participants to attend naturally to an emotional situation (such as emotional film clips or pictures) and then at some time point (hypothetically during Iteration 1 or Iteration 3 in Figure 2) an instruction to start regulating appears (Koole, Van Dillen, & Sheppes, in press; Sheppes, Catran, & Meiran, 2009; Sheppes & Meiran, 2007, 2008; Urry, 2009).

Clearly, it is crucial to utilize contexts in which elapsed time is a suitable proxy for emotional intensity. One such context is viewing a sad film. Theoretically, sadness is conceptualized as an emotion that develops through a slow and steady increase in intensity over time (see Damasio, 1999). Empirically, studies by Mauss and colleagues (2005) have shown that in sadness-inducing films, experiential, behavioral, and some physiological indices jointly develop and increase in intensity over time. Goldin et al. (2005) have further shown that increases in sadness intensity follow a smooth temporal evolution that gradually reaches a peak that can be observed by a steady state BOLD response in fMRI imaging of emotion-generative brain regions. Therefore, in the initial studies described below, where we provide the first direct empirical test of the generic timing hypothesis, film-induced sadness was used as the target emotion (Sheppes et al., 2009; Sheppes & Meiran, 2007, 2008).

Consistent with the process-specific timing hypothesis, findings indicated that distraction was equally effective in attenuating negative affect under low and high levels of emotional intensity (Sheppes & Meiran, 2007). Support for distraction's engagement of early selection processes was demonstrated by impaired memory for emotional details of the sadness-inducing film (Sheppes & Meiran, 2007, 2008). This result indicates that once distraction is operating, the regulatory process blocks incoming emotional information at an early encoding phase, thereby preventing elaborated processing. Crucially, even under high levels of emotional intensity, distraction did not result in increased recruitment of cognitive control resources, indicative of the relative minimal resource requirement in the operation of the strong early filtering mechanism in distraction (Sheppes et al., 2009; Sheppes & Meiran, 2008).

In sharp contrast to the consistent effects of distraction at low versus high levels of emotional intensity, reappraisal had different effects under low versus high levels of emotional intensity (Sheppes & Meiran, 2007). Specifically, under low levels of emotional intensity, reappraisal modulated negative emotional experience relative to a control condition in which participants responded naturally. Reappraisal also eliminated semantic activation of sadness-related memory concepts, erasing the faster reaction times usually seen for sadness versus neutral words in a lexical decision task. However, under high levels of emotional intensity, reappraisal resulted in higher negative affect and in impaired ability to regulate sadness, manifested in slow and limited recall of happy autobiographical memories. The notion that in reappraisal incoming emotional information passes the early filter and is provided elaborated semantic meaning prior to being modified is supported by finding intact memory for emotional information that was presented after participants began using reappraisal (Richards & Gross, 2000; Sheppes & Meiran, 2007, 2008). Furthermore, reappraisal's increased recruitment of the effortful late selection filter when reinterpreting high intensity levels of existing and new emotional information was demonstrated by showing that reappraisal resulted in reduced self-control ability in a subsequent cognitive task (the classic Stroop task) that measures semantic conflict monitoring and resolution (Sheppes & Meiran, 2008). The explanation for this result is based on an ego depletion rationale (Muraven & Baumeister, 2000) where tasks that require high monitoring and intense conflict resolution result in a temporary depletion of self-regulatory resources that is manifested in lower performance in a subsequent similar task. In addition, when operating under high emotional intensity, reappraisal also resulted in increased physiological sympathetic activation (increased skin conductance and reduced finger temperature), which has previously been interpreted as reflecting the increased monitoring demand that characterizes a strong semantic conflict (Sheppes et al., 2009).

Finally, the process-specific timing hypothesis predicts that factors that strengthen late selection reappraisal should moderate the effects of high emotional intensity. One such factor that was examined is the duration of the regulatory process. Just as emotions develop and increase in intensity over time, it was expected that the regulatory process would increase in strength when it is applied for a long duration (but not so long as to lead to fatigue). As expected, when reappraisal was provided an extended time to operate, it successfully overcame high intensity levels of negative emotion (Sheppes et al., 2009; Sheppes & Meiran, 2007, 2008).

In more recent studies, we have further explored differences between early selection distraction and late selection reappraisal. To test the different underlying mechanisms in early selection distraction and late selection reappraisal directly (a core element in the process-specific timing hypothesis), we investigated the temporal dynamics of distraction and reappraisal using electroencephalography (Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2010).

Specifically, we concentrated on the modulation of an event-related potential component (the late positive potential, LPP) that is enhanced during viewing of emotionally arousing compared to neutral stimuli (see Hajcak, MacNamara, & Olvet, 2010, for a review). Importantly for present purposes, the early phase of the LPP reflects the time point when a stimulus is attended and thus represented in working memory, and the late phase reflects semantic elaboration (see Schupp, Flaisch, Stockburger, & Junghofer, 2006, for a review). Supporting our process-specific timing hypothesis, we found that distraction modulated the LPP at the earliest stage, a time point when emotional information is first differentiated from neutral stimuli. This result suggests that distraction blocks emotional information at an early attentive stage before it is represented in working memory and provided elaborated meaning. By contrast, reappraisal modulated the LPP only at a late point after emotional information was provided elaborated semantic evaluative meaning. Furthermore, and consistent with the differential effect of high emotional intensity on distraction versus reappraisal, we found that when people faced relatively high emotional intensity stimuli, distraction resulted in a stronger LPP modulation relative to reappraisal. In addition to providing direct support for the differential operation of distraction and reappraisal, the emotional stimuli used in this study were quite different from the sadness films used in earlier work (i.e., high negative arousing emotional pictures that evoke fear, disgust). This finding suggests that our prior findings using sadness generalize to other emotional states.

A second neuroimaging study provides additional converging support for the notion that distraction and reappraisal are supported by partially separable neural systems that may be differentially effective under high emotional intensity (McRae, Hughes, Chopra, Gabrieli, Gross, & Ochsner, 2010). Specifically, distraction was shown to recruit specific prefrontal and parietal brain regions that have been linked to attentional control, whereas reappraisal recruits lateral and medial prefrontal brain regions that have been associated with cognitive control and affective meaning processing. Interestingly, this study, which used relatively high emotional intensity stimuli from a wide variety of contexts, showed that amygdala modulation was stronger for distraction than for reappraisal. This result suggests that under relatively high emotional intensity, attentional control mechanisms that block emotional information at an early selection processing stage may be more effective than cognitive control mechanisms that influence later-stage semantic processing.

Toward a Process-Specific Timing Framework

One way of linking these empirical findings to our conceptual framework is presented in Figures 4 and 5. From the process-specific timing perspective, the central factor that determines whether emotional intensity influences and dominates the final outcome is the operating process that underlies a particular form of emotion regulation. In particular, early selection strategies should be relatively unaffected by the intensity of an emotional response, and late selection strategies should be affected in a way that depends on the relative strength of emotion-generative versus emotion-regulatory processes. To explain the differential operation of distraction and reappraisal under low and high levels of emotional intensity, it is useful to more closely examine how the processing stage with which each strategy operates deals with preexisting and new incoming emotional information.

Under conditions of low emotional intensity, both distraction and reappraisal should be effective. Figure 4a shows that distraction replaces (denoted by the X) low intensity levels of existing emotional information (arrow S1) with an independent neutral information stream (arrow S2; the neutral thoughts one thinks of when distracting). In addition, incoming emotional information (arrow S3) is fully blocked by the early selection filter. In reappraisal, existing and incoming emotional information are treated in the same manner. Figure 4b shows that reappraisal can modulate low intensity levels of existing and incoming (arrow S1) emotional information. This is achieved by modifying weak emotional information with a dependent neutral reinterpretation (arrow S1′) via a late selection filter.

Under conditions of high emotional intensity, distraction and reappraisal diverge. Figure 5a shows that distraction can still replace existing emotional information with an independent neutral information stream. In addition, incoming emotional information is still fully blocked by the strong early selection filter. By contrast, Figure 5b shows that reappraisal can no longer modify existing emotional information of high intensity with a dependent neutral reinterpretation. In this case, high intensity levels of existing and incoming emotional information are not fully modified by the weak late selection filter, and the dependent neutral reinterpretation is outperformed by strong emotional processing. However, as portrayed in Figure 5c, when the neutral reinterpreted emotional response is strong, it can dominate the outcome by outcompeting a strong intensity emotional response. That is, in this case, reappraisal can modify high intensity emotional information with a strong neutral reinterpretation at a late processing stage.

Our process-specific framework raises several theoretical issues that require further elaboration. In our conceptual framework, we have utilized timing as a proxy for emotional intensity. We have further shown that under some circumstances, such as for emotions like sadness, the passage of time (at least at certain time scales) reliably predicts increases in emotional intensity. However, different emotional situations can have quite different temporal characteristics, including different dynamics and intensities. In most

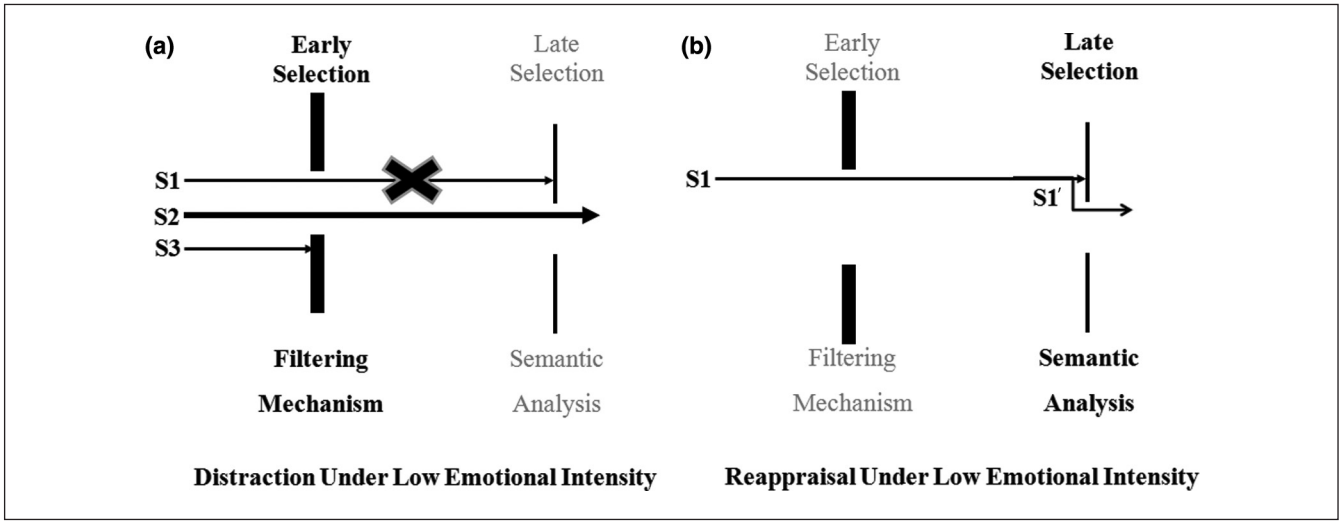

Figure 4. Process-specific timing hypothesis for distraction and reappraisal under low emotional intensity
The thickness of each filter reflects its strength and is inversely related to its use of cognitive resources. Thus, the early filter is stronger and uses fewer resources than the late filter. The thickness of each arrow represents its relative strength, with thicker arrows inducing stronger influence on the final response, which is represented in the right side of the figure. (a) Operation of distraction under low emotional intensity. Low intensity existing emotional information (thin arrow S1) is being replaced (indicated by the X notation) by a strong independent neutral stream of information (thick arrow S2) that is dominating the final response. In addition, incoming emotional information is filtered out at an early selection phase (the thin arrow S3 is blocked by the strong early filter). (b) Operation of reappraisal under low emotional intensity. In reappraisal, existing and incoming emotional information are treated in the same way (indicated by a single S1 notation for both types of emotional information). Low intensity levels of existing and incoming emotional information (thin arrow S1) are successfully modified with a dependent neutral reinterpretation (thin arrow S1′) via the late selection filter. The neutral reinterpretation dominates the final response.

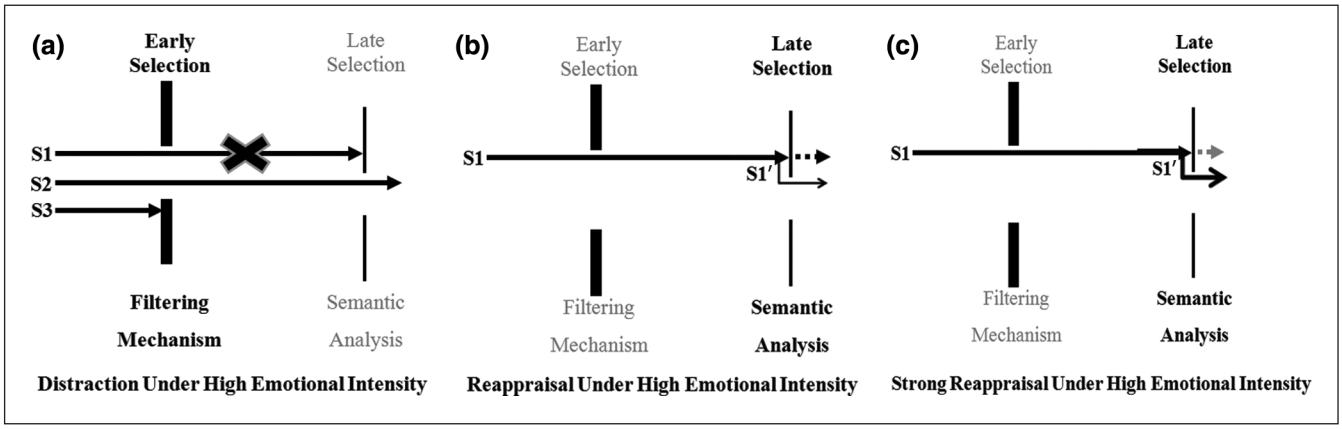

Figure 5. Process-specific timing hypothesis for distraction and reappraisal under high emotional intensity
The thickness of each filter reflects its strength and is inversely related to its use of cognitive resources. Thus, the early filter is stronger and uses fewer resources than the late filter. The thickness of each arrow represents its relative strength, with thicker arrows inducing stronger influence on the final response which is represented in the right side of the figure. (a) Operation of distraction under high emotional intensity. High intensity existing emotional information (thick arrow S1) is being replaced (indicated by the X notation) by a strong independent neutral stream of information (thick arrow S2). In addition, incoming emotional information is filtered out at an early selection phase (the thick arrow S3 is blocked by the strong early filter). The independent neutral information dominates the final response. (b) Operation of reappraisal under high emotional intensity. In reappraisal, existing and incoming emotional information are treated in the same way (indicated by a single S1 notation for both types of emotional information). High intensity existing and incoming emotional information (thick arrow S1) are not fully modified by a dependent neutral interpretation (thin arrow S1′) via the late selection filter. As a result, emotional information passes through the late selection filter (indicated by a dashed arrow that passes through the late selection filter and affects the response). Therefore, the dependent neutral reinterpretation of the emotional information (thin arrow S1′) only partially affects the final response and is being outweighed by the strong emotional information. (c) Operation of strong reappraisal under high emotional intensity. In strong reappraisal, high intensity existing and incoming emotional information (thick arrow S1) are successfully modified by a strong dependent neutral reinterpretation (thick S1′) via the late selection filter. The strong dependent neutral reinterpretation outweighs the emotional information (indicated by weak dashed arrow that passes through the late selection filter) and dominates the response.

cases, a monotonic increase in time does not necessarily correspond to a monotonic increase in emotional intensity. Clearly, different emotional responses develop at different speeds and through different developmental profiles. For example, one's past experience with a certain emotional stimulus could dramatically affect the speed with which emotion changes in intensity via processes such as sensitization, habituation, or adaptation.

Therefore, when trying to test the influence of emotional intensity on different emotion regulation strategies, one would ideally have a clear and direct estimate of the intensity of the emotion-generative process prior to the initiation of emotion regulation. Typically, this would involve measuring individuals' intensity changes in emotional response systems (i.e., experiential, behavioral, physiological). However, even though emotional intensity is a major aspect of most emotion theories, the actual definition and measurement remains either unexplored or disputed (see Reisenzein, 1994, for a discussion). Empirically, studies on emotion coherence show that emotional response systems are only loosely coupled, making the increase in intensity in one response system only partially synchronized with increases in a second response system (Mauss et al., 2005). Furthermore, emotion regulation strategies may differentially affect different emotional response systems. For example, studies in expressive suppression show that it involves reducing emotion-related facial behavior, increasing peripheral physiological responses and not changing subjective experience (see Gross, 2002, for a review). Accordingly, one needs to take into account these complicated characteristics when trying to evaluate intensity prior to and during the initiation of a regulatory strategy and when evaluating the effectiveness of regulatory strategies. Nevertheless, as long as intensity is carefully considered and measured, the basic logic of the process-specific framework where late selection strategies should be more affected than early selection strategies should apply.

In addition to elucidating emotional intensity, the time scale of an emotional episode also requires clarification. According to the process model, emotions develop through a series of situation–attention–meaning response iterations. Unlike moods, which can last for days, weeks, or even months, emotions often develop and then subside within a range of seconds or minutes. Empirically, when testing the process-specific timing hypothesis, we have looked at novel emotional events that last several minutes. Therefore, extensions to prolonged mood states should be examined separately.

One other consideration is whether any given emotional response was evoked in a bottom-up manner (e.g., by experiencing disgust as a result of smelling outdated milk) or in a top-down manner (e.g., by recollecting smelling the outdated milk). In bottom-up emotion generation, information is gathered from an external stimulus and attentional processes presumably precede evaluative processes. However, in top-down emotion generation, an emotion could be created by a semantic evaluation. Our account deals with both examples in the same way. That is, whether created in a bottom-up or top-down fashion, the ongoing emotional response can be regulated using an early selection strategy such as distraction or a late selection strategy such as reappraisal. Nonetheless, the process-specific framework predicts that bottom-up emotional responses would be less effectively modulated with late selection strategies relative to top-down emotion generation (McRae, Misra, Prasad, Pereira, & Gross, 2010). The logic for this prediction is based on a recent study that demonstrated that bottom-up generation, relative to top-down emotion generation, resulted in stronger activation of the amygdala (Ochsner et al., 2009).

Implications and Applications of the Process-Specific Timing Framework

In this final section, we extend the process-specific framework to account for other early and late selection regulation strategies besides distraction and reappraisal. We then provide further predictions that derive from the framework and suggest directions for future research in developmental, decision-making, and clinical contexts.

We have argued on theoretical grounds—and demonstrated empirically—that the impact of emotional intensity on emotion-regulation-related outcomes depends on the operating process of the regulation strategy. Specifically, we have concentrated on whether the emotional response is being blocked by an early or late selection filter. Our focus has been on two antecedent-focused regulation strategies, one form of early selection emotion regulation (distraction), and one form of late selection emotion regulation (reappraisal). However, we believe that our process-specific timing framework is applicable to other antecedent early and late selection forms of emotion regulation as well.

Other strategies besides reappraisal are likely to be influenced by the level of emotional intensity prior to the initiation of regulation. For example, rumination, which involves a perseverative focus on negative feelings and their consequences (e.g., Nolen-Hoeksema, 1991), is also likely to be affected by the initial emotional intensity. Rumination involves enhanced attentional focus and semantic elaboration of emotional information. According to our account, in rumination, emotional information passes through the early selection filter and is magnified prior to passing the late selection filter. Accordingly, when emotional intensity is high, the perseverative focus of rumination is boosted and becomes maladaptive (e.g., Nolen-Hoeksema & Morrow, 1993). This analysis dovetails with a study by Joormann and Gotlib (2008) in which the authors developed a measure to isolate specific late processing impairments of negative information. Specifically, this measure, a modified working

memory-updating task, evaluates the person's ability to remove negative information that has passed the early processing stage and was given semantic meaning. Importantly, these late processing impairments were highly correlated with rumination.

Our analysis of rumination also is consistent with recent findings of Urry (2009), who showed that increasing negative affect by reappraising an emotional situation as getting worse is potentiated when negative emotion is sufficiently developed. As with rumination, this case of (up-regulation) reappraisal involves information passing the early processing stage and being boosted in the late processing stage by potent negative representations.

According to the same logic, other strategies (in addition to distraction) that compete with the emotional process at an early processing stage are predicted to be minimally affected by the initial level of emotion. Specifically, strategies such as avoidance are likely to operate with the same efficiency (and costs) irrespective of the level of emotional intensity. Avoidance, like distraction, replaces existing emotional information and prevents incoming emotional information from being further processed, thus changing the emotional representation with minimal effort.

In addition to extending our framework to different emotion regulation strategies, the process-specific hypothesis provides several further predictions. Our account suggests that regulation strategies that affect the early processing stage should provide fast and effective relief from negative affect and thus fulfill a short-term hedonic goal of avoiding unpleasant emotions (e.g., Tamir, 2009). In some cases, this short-term goal is clearly adaptive. However, our framework can also account for long-term effects of early selection strategies that may be maladaptive because strategies such as distraction and avoidance prevent emotional information from being deeply processed, which means that no monitoring or resolution of the causes of the emotional reaction is possible. Therefore, the same factors that make early processing strategies provide fast relief in the short run may account for maladaptive consequences in the long run.

Kross and Ayduk (2008) provided evidence that supports this view, showing that although distraction attenuated sad mood in the short run, it did not lead to changes in the way negative experiences are evaluated and responded to in the long run. In a similar vein, avoidance seems to be so effective that it becomes generalized to an extent that it becomes a dominant regulatory solution for dealing with intense emotional responses, resulting in psychopathology. Avoidance provides quick relief from an aversive emotional response, but in the long run this emotion regulation strategy becomes maladaptive for the same reasons that it works quickly; it does not allow elaborated processing and consequential understanding of the emotional event that is crucial for adaptation (Campbell-Sills & Barlow, 2007). The fact that late but not early selection strategies could prove effective in the long run also agrees with Wilson and Gilbert's (2008) model of affective adaptation. According to this model, emotional adaptation occurs when a person attends to an emotional event and explains it. In the present case, late strategies such as reappraisal but not early selection strategies such as distraction involve attending to and reinterpreting emotional events.

A second prediction that derives from our framework is that high emotional intensity is likely to activate hedonic regulatory goals that aim to achieve immediate relief by avoiding unpleasant states (see Tamir, 2009). Support for this view comes from a study that showed that, under high emotional distress, individuals choose to use emotion regulation strategies that offer short-term relief (Tice, Bratslavsky, & Baumeister, 2001). Accordingly, we suggest that a strong hedonic goal that is activated by high negative affect will likely spontaneously recruit early processing strategies that offer quick relief.

A third prediction that derives from our account is that strengthening the regulatory process will reduce the costs of late processing strategies. One interesting finding described earlier is that when reappraisal was implemented for an extended duration, it was effective in reducing emotional intensity. We interpret this finding as showing that factors that affect the strength of the regulatory process may aid late processing strategies even in the context of relatively intense emotions. If so, any factor that strengthens the late processing regulatory process can potentially tilt the direct semantic conflict in favor of the regulatory process. For example, prolonged training in reappraisal may create a situation in which the monitoring and resolution of the conflict with the emotional representation may become less effortful and costly even under high intensity levels of negative affect. This idea fits with information processing findings that show that tasks that become automatic because of practice do not require the limited capacity of the semantic late selection (Pashler, 1988). Alternatively, automatic emotion regulation (see Williams, Bargh, Nocera, & Gray, 2009) may also activate the regulatory goal without enhanced conscious effort.

Our process-specific timing account allows us to begin to map the effectiveness of different emotion regulation strategies under different levels of emotion intensity. We believe that our framework may prove generative and offers several directions for future research.

First, we have concentrated on emotion-generative and emotion-regulatory processes in adults. However, one of the most important developmental tasks in early childhood is developing the ability to regulate one's emotions (e.g., Macklem, 2008). Intense emotional outbursts such as strong nightmares, powerful fears, and temper tantrums are prevalent among young children. This is likely because of an imbalance between relatively strong emotion-generative processes and relatively weak emotion-regulatory abilities. Therefore, young children are likely to find themselves in

intense emotional states. Future studies should examine whether under these extreme emotional intensities, children can be taught a set of skills that are easy to apply to offer fast relief. This can be accomplished via early selection strategies that operate quickly and are easy to implement. From a developmental perspective, forms of self-distraction develop earlier than forms of reappraisal. Infants as young as 6 months of age look away from distressing stimuli, and by the age of 24 months self-distraction is both most common and successful in regulating fear and distress (Grolnick, Bridges, & Connell, 1996). Reappraisal, which among other things demands thinking about emotions from a different perspective, develops considerably later. This developmental progression fits nicely with our account and suggests that in the midst of intense emotional reactions, distraction may operate faster than reappraisal.

Second, our demonstration that late selection strategies become costly under high emotional intensity could be important for fields such as decision making. It has been well established that emotions affect decision making (e.g., Loewenstein, 2000), and studies have shown that the effects of intense emotional states on decision making may be the result of ineffective use of emotion regulation (Heilman et al., 2010). Specifically, reappraisal may be an effective way to neutralize negative emotions and improve decision making. Our account suggests that a consideration of when reappraisal is initiated may be crucial. Specifically, applying reappraisal during an intense emotional state may require effortful conflict monitoring and resolution, which may deplete the resources needed to ward off impulsive decision tendencies. Accordingly, future studies should examine whether a fast modulation of an intense emotional state with early selection strategies such as distraction reduces the effort and costs of applying reappraisal as a second step.

Third, developments in clinical science suggest that individuals with various psychopathologies display emotion regulation deficits (e.g., Menin, Heimberg, Turk, & Fresco, 2005). Accordingly, several treatment protocols focus on teaching clients efficient emotion regulation skills (e.g., Barlow, Allen, & Choate, 2004; Linehan, 1993). According to our framework, treatment protocols should involve teaching clients not only *which* emotion regulation strategies are effective but also *when* certain strategies should be used. Distraction (but not reappraisal) may be used as first aid for intense emotional responses because it attenuates negative mood quickly and effectively, at least in the short run.

This suggestion fits well with a recent model of attention training methods (Wadlinger & Isaacowitz, in press). In this model, distraction is a key feature in several emotion regulation training programs (e.g., dot probe and visual search programs) and is assumed to involve low cognitive effort to execute. Similar ideas were put forth by major treatment protocols for anxiety, mood, and personality disorders (see Campbell-Sills & Barlow, 2007; Linehan, Bohus, & Lynch, 2007). For example, in dialectical behavioral therapy (DBT; Linehan et al., 2007) patients with borderline personality disorder are taught two sets of skills to deal with their emotions: distress tolerance for highly intense emotional states and emotion regulatory skills for lower intensity emotional states and for achieving long-term benefits. Interestingly, one of the distress tolerance skills is distraction and the other skills (e.g., performing progressive relaxation) fit the early selection regulatory category. Similarly, one of the emotion regulatory skills involves some forms of reappraisal or other skills that can be characterized by late selection regulatory efforts (e.g., testing the facts). Future studies should empirically test the rationale of DBT's approach by showing that early selection strategies such as distraction provide quick and relatively effortless relief from intense emotional states. However, even though distraction offers immediate relief from distressing situations, it does not permit deeper processing. Therefore, distraction may prove unsuitable in instances in which successful resolution depends on continued monitoring and active engagement with emotional events. Accordingly, combining late selection strategies such as reappraisal after negative mood has somewhat subsided may prove useful.

Concluding Comment

Successful emotion regulation requires appropriate timing as well as appropriate strategy selection. The process model of emotion regulation has distinguished among emotion regulation processes and articulated a generic timing hypothesis, which holds that early intervention is generally preferable to late intervention. This process conception has been valuable in organizing regulatory strategies according to the point in time in which they intervene in the emotion-generative process. This framework has encouraged scholars to distinguish between antecedent response strategies that start operating early (e.g., reappraisal) and response-focused strategies (e.g., suppression) that intervene late.

Supporting evidence for the generic timing hypothesis has largely been indirect, consisting of contrasts between types of emotion regulation that are thought to differ in the point at which they have their primary impact on the emotion-generative process. In this article, we have drawn on an information-processing perspective to suggest a process-specific timing hypothesis. Using this perspective as a guide, we showed that the basic operating process of regulation strategies and the strength of the regulatory process predict whether different regulation strategies are affected by concurrent intensity level of the emotional response. This process-specific timing conception retains the basic focus of the process model but refines this conception by articulating how and when emotion-generative processes may interact with emotion-regulatory processes in a way that influences emotional outcomes. We hope that this framework will be

useful and generative to those interested in effective emotion regulation under conditions of varying emotional intensity.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Financial Disclosure/Funding

The author(s) received the following financial support for the research and/or authorship of this article:
The first author was supported by the Rothschild Post-doctoral Fellowship from Yad Hanadiv.

Note

1. In this article, we focus on emotion down-regulation, where the regulatory goal is to decrease the intensity of emotion. Accordingly, when we refer to effectiveness, we mean how successful a regulatory strategy is at decreasing emotional intensity per unit of effort expended.

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