

How Anticipatory Information Shapes Subsequent Emotion Regulation

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Individuals often receive preceding information concerning future unpleasant events that will require regulating emotions. However, conceptual accounts explaining how the presence of anticipatory information, as well as biases in the content of anticipatory information, influence subsequent emotion regulation are lacking. We propose a novel account that explains how the cognitive processing of anticipatory information influences subsequent cognitive regulatory strategies. Specifically, the presence (vs. absence) of anticipatory information, which primarily influences attention toward upcoming unpleasant events, largely impacts *attention-modulation* regulatory strategies. By contrast, biased (vs. unbiased) contents of anticipatory information, that primarily influence the meaning of upcoming unpleasant events, largely impact *meaning-modulation* regulatory strategies. Our account further argues that the fit between the direction of influence of anticipatory information on cognition and the underlying mechanisms of cognitive down-regulation strategies determines regulatory challenge (i.e., effort and effectiveness of regulation). When anticipatory information decreases attention to, or negative meaning of, upcoming unpleasant stimuli, it fits a subsequent down-regulation goal to decrease attention or negative meaning, resulting in low regulatory challenge. However, when anticipatory information enhances attention to, or negative meaning of, upcoming unpleasant stimuli, it conflicts with a counter down-regulation goal to decrease attention or negative meaning (i.e., no fit), resulting in high regulatory challenge. Broad implications and future directions are discussed.

Keywords: anticipatory information, emotion regulation, attention, meaning, late positive potential

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From personal “sit down, something bad happened” statements before receiving painful news, to more formal trigger warnings and medical consents preceding potentially stressful events—we often receive preceding information concerning future emotionally unpleasant events that will require regulating emotions. How will the mere receipt of anticipatory information prior to stressful events influence emotion regulation during these events? When anticipatory information is received, how do biases in its content influence subsequent regulation?

While raising considerable interest, systematic answers to these questions are missing. To fill this gap, we propose a dual-component conceptual account that explains how anticipatory information influences subsequent regulation. Our account focuses on cognitive regulatory strategies—a central category that involves

recruiting deliberate executive control processes to modulate emotions.

How Anticipatory Information Shapes Cognition

The first component of our account delineates how anticipatory information influences cognitive processing of subsequent emotional events. Specifically, we draw from studies showing how anticipatory information impacts deployment of *attention* to, and *meaning* of, subsequent emotional events. Given the rapid evolution of attention and meaning cognitive processes, we primarily review studies that utilized the high temporal resolution of Event Related Potentials (ERPs)—electrical time-locked neural changes (Luck, 2014). Special focus is given to the Late Positive Potential (LPP), an ERP component typically divided into two phases—an early phase indexing initial attention toward emotional stimuli (Foti & Hajcak, 2008; MacNamara, Foti, & Hajcak, 2009; Moser, Hartwig, Moran, Jendrusina, & Kross, 2014), and a late phase denoting meaning processing of emotional stimuli (Hajcak, MacNamara, & Olvet, 2010 for a review).

Below, we categorize prior studies into those concentrated on the mere presence of unbiased anticipatory information, and those concentrated on biases in the content of anticipatory information. Notably, in all of these studies, anticipatory information referred to features of external unpleasant future events, and was provided explicitly. We define unbiased anticipatory information to refer to details evident in the actual upcoming unpleasant stimulus, which are not likely to influence the negativity of its meaning. By

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contrast, biased anticipatory information conveys details that are not evident in the actual upcoming unpleasant stimulus and are likely to influence the negativity of its meaning.¹

How the Presence of Unbiased Anticipatory Information Influences Cognition

Studies manipulating the mere presence (vs. absence) of unbiased anticipatory information consistently show alteration in attention toward (but not meaning of) subsequent unpleasant stimuli (Carlsson et al., 2006; Gole, Schäfer, & Schienle, 2012; Herry et al., 2007; Lin et al., 2012, 2014; Lin, Xiang, Li, Liang, & Jin, 2015; Waugh, Fredrickson, & Taylor, 2008). The direction of influence on attention appears to vary depending on the type of anticipatory information provided.

Specifically, several studies provided or did not provide unbiased anticipatory information regarding valence (e.g., a visual cue indicating an upcoming picture would be unpleasant or a control visual cue not providing valence information). Results demonstrated that anticipatory information about valence enhances attention toward unpleasant pictures, manifested in enhanced early-LPP amplitudes, and also increases negative experience (Gole et al., 2012; Lin et al., 2012, 2014, 2015; Waugh et al., 2008). Other studies that used unpleasant stimuli only (pictures or shocks) provided or did not provide unbiased anticipatory information regarding their timing (e.g., a visual digit countdown until the onset of the unpleasant stimulus or a control condition with random digits). Anticipatory information about timing decreased attention toward unpleasant stimuli, manifested in decreased early-LPP amplitudes (Nelson & Hajcak, 2017), decreased spatial attention toward unpleasant stimuli (Herry et al., 2007), and reduced activation in brain regions associated with attention to aversiveness (Carlsson et al., 2006). Furthermore, presenting anticipatory information regarding timing reduced self-reported (Carlsson et al., 2006; Nelson & Hajcak, 2017) and neural indices (Herry et al., 2007) of anxious responses.

How Biased Content of Anticipatory Information Influences Cognition

A second class of studies asked: for presented anticipatory information, how do content biases influence subsequent emotional responses. Here, results consistently show alterations in the negative meaning of subsequent unpleasant stimuli (Foti & Hajcak, 2008; MacNamara et al., 2009; MacNamara, Ochsner, & Hajcak, 2011; Mocaiber et al., 2011; Strauss et al., 2013; Zhang et al., 2016). Specifically, negatively biased anticipatory information (e.g., the auditory description: “This patient died due to doctor malpractice”) enhanced the meaning processing of subsequent unpleasant pictures (e.g., a picture depicting a medical surgery), relative to less negatively biased anticipatory information (e.g., “This is a routine surgery”), manifested in enhanced late-LPPs (Foti & Hajcak, 2008; MacNamara et al., 2009, 2011; Strauss et al., 2013; Zhang et al., 2016). Additionally, negatively biased anticipatory information increased self-reported unpleasantness (Foti & Hajcak, 2008; Mocaiber et al., 2011; Strauss et al., 2013; Zhang et al., 2016) and activation in brain regions associated with emotional responses (Mocaiber et al., 2011).

Underlying Mechanisms of Cognitive Regulatory Strategies

While the first component of our account delineated how anticipatory information shapes cognitive processing of subsequent unpleasant events, it did not refer to emotion regulation strategies, which constitute the second component. Corresponding to the influence of anticipatory information on attention to, and meaning of, subsequent unpleasant events, cognitive emotion regulation essentially targets two major information processing stages—*attention-modulation* and *meaning-modulation* (Ochsner & Gross, 2005; Sheppes, in press; Sheppes & Gross, 2011 for conceptual reviews). Our account focuses on *down-regulation* goals (see below extension to up-regulation). Specifically, attention-modulation down-regulation involves early attentional disengagement from unpleasant events, whereas meaning-modulation down-regulation involves attending to unpleasant events, but later reducing their negative meaning.

Converging empirical evidence shows the distinct underlying mechanisms of attention-modulation versus meaning-modulation down-regulation. Behaviorally, early attention-modulation disengagement involves minimal meaning processing, which impairs memory of emotional events, while late meaning-modulation leaves memory intact (e.g., Sheppes & Meiran, 2007, 2008). Neurally, attention-modulation attenuates the early-LPP, while meaning-modulation attenuates the late-LPP (e.g., Shafir, Schwartz, Blechert, & Sheppes, 2015; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011). Furthermore, neuroimaging studies demonstrate distinct attentional control versus meaning processing neural systems involved in attention-modulation and meaning-modulation, respectively (e.g., McRae et al., 2010).

How Anticipatory Information Shapes Emotion Regulation: A New Account

Our dual-component conceptual account integrates between the influence of anticipatory information on cognition (attention vs. meaning), and the mechanism of down-regulation strategies (attention-modulation vs. meaning-modulation), to predict *regulatory challenge*. Regulatory challenge refers to the degree of regulatory effort (high or low), regulation effectiveness (high or low), or both.²

Our account answers two fundamental questions separately. First, we consider how the mere presence (vs. absence) of anticipatory

¹ Empirical support for our definition of unbiased versus biased anticipatory information comes from studies showing that: (a) unbiased anticipatory information does not alter the negative meaning of actual unpleasant stimuli, compared to a no anticipatory information condition, manifested in similar late-LPPs (e.g., Lin, Xiang, Li, Liang, & Jin, 2015; Shafir & Sheppes, 2018); (b) Biased anticipatory information alters the negative meaning of actual emotional stimuli, compared to an unbiased anticipatory information condition, manifested in enhanced late-LPPs for negatively biased information and reduced late-LPPs for less negatively biased information (e.g., Foti & Hajcak, 2008; MacNamara, Ochsner, & Hajcak, 2011).

² We use the broad term *regulatory challenge* because many prior studies remain vague with regard to the differentiation between regulatory effort and regulatory efficacy. Note, though, that at least in some contexts, enhanced regulatory effort and less regulatory success tend to occur together (e.g., Shafir et al., 2015; Sheppes, Brady, & Samson, 2014; see Sheppes, in press; Sheppes & Gross, 2011 for conceptual reviews).

information influences subsequent down-regulation (Figure 1A). To accurately answer this question, we refer to the presence of unbiased anticipatory information.³ Our account is then applied to answer the second question: for presented anticipatory information, how do biased (vs. unbiased) contents of anticipatory information impact subsequent down-regulation (Figure 1B, see Footnote 3).

A) Given that the presence (vs. absence) of anticipatory information mainly influences attention to (but not meaning of) upcoming unpleasant events, our account predicts that it would largely impact subsequent down-regulation forms whose underlying mechanism involves attention-modulation.⁴

Regulatory challenge is determined by the fit between the direction of influence of anticipatory information on cognition (i.e., enhancing or decreasing attention), and the mechanism of attention-modulation down-regulation (i.e., decreasing attention). When the presence of anticipatory information enhances attention to upcoming unpleasant stimuli (as in the case of information about valence), it is expected to conflict with a subsequent counter down-regulation goal to decrease attention to these stimuli (i.e., no fit), resulting in high regulatory challenge. By contrast, when the presence of anticipatory information decreases attention to upcoming unpleasant stimuli (as in the case of information about timing), it is expected to fit a subsequent down-regulation goal to decrease attention, resulting in low regulatory challenge. Last, when the presence of anticipatory information does not influence attention to upcoming unpleasant stimuli, it will have minimal impact on subsequent attention-modulation regulation.

B) Given that biased (vs. unbiased) content of anticipatory information mainly influences the meaning of (but not attention to) upcoming unpleasant events, our account predicts that it would largely impact subsequent down-regulation forms whose underlying mechanism involves meaning-modulation.

Consistent with the above logic, regulatory challenge is determined by the fit between the direction of influence of anticipatory information on cognition (i.e., enhancing or decreasing negative meaning), and the mechanism of meaning-modulation down-regulation (i.e., decreasing negative meaning). In cases where the biased content of anticipatory information enhances the negative meaning of upcoming unpleasant stimuli, it is expected to conflict with a subsequent counter down-regulation goal to decrease negative meaning (i.e., no fit), resulting in high regulatory challenge. By contrast, when the biased content of anticipatory information decreases the negative meaning of upcoming unpleasant stimuli, it is expected to fit a subsequent down-regulation goal to decrease negative meaning, resulting in low regulatory challenge. Last, when the content of anticipatory information is objective and unbiased, it will have minimal impact on the meaning provided to upcoming unpleasant stimuli, and thus minimal impact on meaning-modulation down-regulation.

Findings from previous studies may agree with the proposed “fit” logic of our account. Specifically, important yet indirect support derives from the extensive coping literature that examined how anticipatory information regarding upcoming stressful medical procedures, influences subsequent affective responses among individuals with opposing coping styles (Miller, 1981; Miller, Fang, Diefenbach, & Bales, 2001; Roussi & Miller, 2014 for reviews). The first “blunting” coping style characterizes individuals who habitually avoid or minimize attention to threatening information (generally coincide with attention-modulation down-

regulation strategies). The second “monitoring” coping style characterizes individuals who habitually seek and engage in meaning-making of threatening information (generally coincide with meaning-modulation down-regulation strategies).

These studies (e.g., Miller & Mangan, 1983; van Zuuren, Gryphonck, Crevits, Vande Walle, & Defloor, 2006) showed that for blunters, anticipatory information was associated with maladaptive affective outcomes, presumably because it was incongruent with their tendency to decrease attention to stressful events. However, for monitors, anticipatory information was beneficial, presumably because it was congruent with their tendency to seek and make meaning of stressful events.

While undoubtedly important, coping studies provide only indirect support for our account. First, the field nature of these studies precludes the inclusion of a clean “no anticipatory information” condition, due to ethical concerns that require providing patients with sufficient anticipatory information regarding upcoming medical procedures. Second, the blunting and monitoring coping styles represent two broad categories that bring several different emotion regulation strategies with distinct mechanisms under the same umbrella. Last, the coping literature is based on self-reported habitual individual differences. As such, it cannot provide an underlying mechanism by which anticipatory information causally influences regulatory strategies.

Direct evidence for how anticipatory information causally shapes subsequent regulation remains limited. We are aware of only two studies exploring our first question regarding influence of the presence (vs. absence) of unbiased anticipatory information on subsequent down-regulation. In the first study, participants received or did not receive unbiased anticipatory information regarding the valence of upcoming social feedback (i.e., a negative or positive emoticon, or question mark), prior to meaning-modulation down-regulation (Liu, Vanderhasselt, Zhou, & Schirmer, 2016). Congruent with the literature on anticipatory information influ-

³ From an empirical point of view, in order to cleanly isolate the effect of the mere presence of anticipatory information, no anticipatory information should be compared with unbiased anticipatory information. An alternative comparison between no anticipatory information and biased anticipatory information, would not allow determining whether subsequent influence on attention-modulation strategies is due to the mere presence of anticipatory information, the notion that it is biased, or both. Similarly, in order to cleanly isolate the effect of biases in anticipatory information, one needs to compare biased anticipatory information to unbiased anticipatory information.

⁴ Since attention and meaning stages are considered sequential, it is not possible to entirely separate the influence of anticipatory information on early attentional processes from the influence of anticipatory information on later meaning processes. Nonetheless, we favored maintaining the differentiation between attention and meaning processes in our account because first, describing the two processes as distinct, which is congruent with the process model of emotion regulation (Gross, 1998), is more parsimonious than describing additional potential interrelations. Second, and most importantly, empirical evidence (e.g., Lin et al., 2015; Shafir & Sheppes, 2018) suggests that in some cases manipulations that influence attention (i.e., early-LPPs) do not influence subsequent meaning (i.e., late-LPPs). Relatedly, while past arguments suggested that the effects of meaning-making strategies may be explained by earlier attentional shifts (e.g., van Reekum et al., 2007), later studies found that at least to some extent the effects of meaning-modulation strategies on both subjective experience and physiology are independent from earlier attentional processes (Bebko, Franconeri, Ochsner, & Chiao, 2014; Manera, Samson, Pehrs, Lee, & Gross, 2014; Urry, 2010).

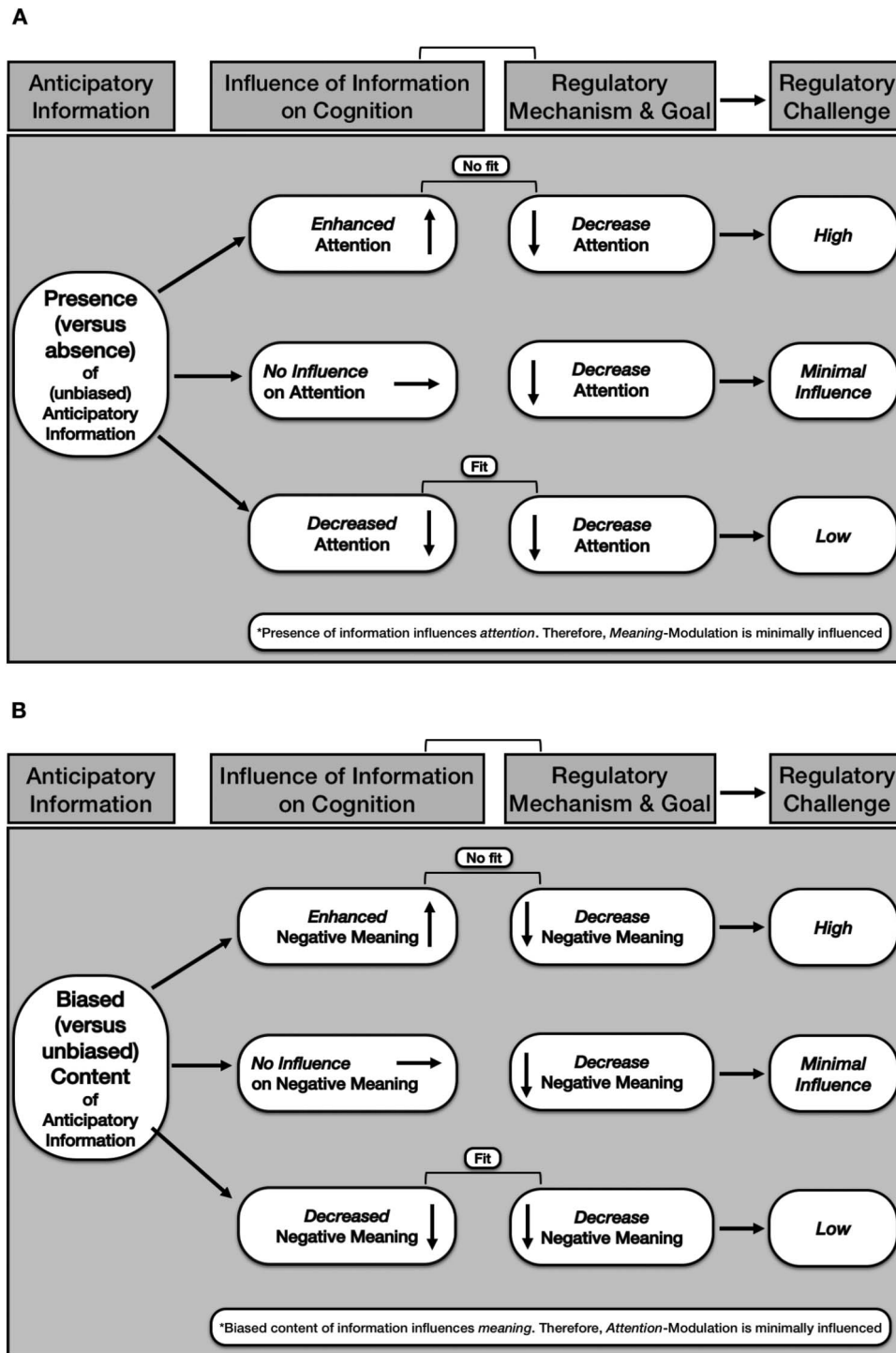


Figure 1. A dual-component conceptual account that explains how: (A) the presence (vs. absence) of anticipatory information, and (B) biased (vs. unbiased) contents of anticipatory information, influence cognition, and how this influence interacts with subsequent attention-modulation and meaning-modulation down-regulation goals to determine regulatory challenge. The figure illustrates the case of a down-regulation goal. In the case of up-regulation, the direction of influence on regulatory challenge is predicted to flip.

ences on cognition, results showed that the presence (vs. absence) of anticipatory information generally enhanced attention to unpleasant social feedback (e.g., “unattractive”), manifested in increased early-LPPs. While our account would predict no influence on later meaning processing (i.e., similar late-LPPs), the authors also concluded that anticipatory information promoted meaning-modulation down-regulation. Nonetheless, it should be noted that this conclusion was based on an analysis of the early-LPP phase per se. An analysis of the late-LPP phase, which is important for measuring how anticipatory information influences meaning-modulation strategies, was not conducted in this study. Additionally, in the absence of an attention-modulation down-regulation condition, this study was unable to test whether the presence (vs. absence) of valence anticipatory information interferes with a regulatory goal to decrease attention.

The second study examined how the presence (vs. absence) of unbiased anticipatory information regarding upcoming unpleasant pictures (e.g., a picture of a car accident preceded by the words *car accident vs. no information*), influences attention-modulation versus meaning-modulation down-regulation (Shafir & Sheppes, 2018, Study 1). Results again supported the literature on anticipatory information influences on cognition, demonstrating that the presence (vs. absence) of anticipatory information generally enhanced attention toward unpleasant pictures, manifested in increased early-LPPs. Importantly, enhanced attention following the presence of anticipatory information selectively conflicted with a subsequent counter down-regulation goal to decrease attention to unpleasant stimuli. This was manifested in sustained increased LPPs (i.e., early but also late) during attention-modulation, but not during meaning-modulation down-regulation. These results appear to support the “fit” logic of our account.

Implications and Future Directions

Modern life provides abundant information regarding future events that will require emotion regulation. It is therefore important to understand how to navigate in ways that promote adaptive functioning. Our novel dual-component account was set to answer two fundamental questions concerning the influence of the presence of anticipatory information as well as biases in its content on subsequent down-regulation. Although our account draws from several literatures, future studies are urgently needed to empirically test the direction of influence of anticipatory information regarding timing on attention-modulation; and how biased contents of anticipatory information influence meaning-modulation.

Theoretical future extensions of our account include transcending down-regulation goals (i.e., decreasing emotional responses) by mapping the influence of anticipatory information on up-regulation (i.e., increasing emotional responses). Akin to the case of down regulation, up-regulation challenge can be predicted by the same “fit” between the influence of anticipatory information on cognition (i.e., enhanced or decreased attention to, or negative meaning of, unpleasant events), and the mechanism of up-regulation strategies. However, because up-regulation goals are opposite in directionality from down-regulation goals, our account predicts that when anticipatory information decreases attention or negative meaning, it would conflict with a subsequent counter up-regulation goal to increase attention or negative meaning (i.e., no fit), resulting in high (up)-regulatory challenge. By contrast,

anticipatory information that enhances attention or negative meaning would fit a subsequent up-regulation goal to increase attention or negative meaning, resulting in low (up)-regulatory challenge.

Our account represents the emerging understanding that emotion regulation is a multistage phenomenon that should be understood in a broader context of processes that precede actual regulatory implementation. While our account focuses on how anticipatory information influences regulatory implementation, another theoretical extension for future studies would be to cover other regulatory stages as well. For instance, anticipatory information could impact the selection stage, that precedes the implementation stage and involves deciding which of currently available regulatory strategies would be chosen (Sheppes & Levin, 2013). The mere exposure to anticipatory information may influence the selection of attention-modulation down-regulation (cf., Gainsburg & Earl, 2018). However, anticipatory information that portrays the meaning of upcoming stressful events as less negative may encourage choosing meaning-modulation down-regulation.

Beyond theoretical extensions, our account has important daily life implications. Individuals are routinely exposed to anticipatory information, such as trigger warnings about potentially unpleasant content or technical information about upcoming stressful medical examinations. In these domains, tailoring between anticipatory information and individuals’ down-regulation efforts is critical for information providers (e.g., doctors) and receivers (e.g., patients, see Roussi & Miller, 2014). For example, when possible, information providers should give less negative anticipatory information to information receivers who try to regulate by decreasing negative meaning. Information receivers also have some degree of control over their anticipatory information seeking behavior. For instance, patients may avoid anticipatory information that enhances attention when regulating via attentional disengagement, by refraining from thoroughly reading consent forms or from actively searching for medical information in websites or forums.

Providing important preliminary support for this notion, we recently showed that choosing to refrain from (vs. seek) anticipatory information that enhanced attention to unpleasant stimuli, resulted in improved attentional distraction success (Shafir & Sheppes, 2018, Study 2). This finding adds important specificity to a large body of research describing information avoidance as a means for emotion regulation (Sweeny, Melnyk, Miller, & Shepperd, 2010 for a review). Specifically, we argue that avoiding anticipatory information can sometimes be beneficial for subsequent down-regulation efforts; for example, when the presence of anticipatory information enhances attention to subsequent unpleasant stimuli, and ones’ down-regulation goal is to decrease attention.

Our account has clinical implications. A basic tenet in several recent interventions involves improving emotion regulation skills (e.g., Berking & Schwarz, 2015; Mennin & Fresco, 2015). Potential additions to current protocols may involve teaching patients when to avoid anticipatory information. For example, patients who wish to disengage their attention from highly unpleasant events in order to obtain short-term relief can be taught to avoid anticipatory information when it enhances attention to these events. Furthermore, patients may be instructed to seek comforting information before using meaning-modulation strategies.

See [online supplemental materials](#) for recommendations for additional reading.

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